

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit E
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

Full Precision	ON	
Confidence Coefficient	95%	
Number of Bootstrap Operations		2,000

Aluminum (mg/kg)

General Statistics

Number of Valid Observations	7	Number of Distinct Observations	7
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Raw Statistics

Minimum	6292	Minimum of Log Data	8.7470343
Maximum	10600	Maximum of Log Data	9.2686093
Mean	8026.1429	Mean of log Data	8.9782344
Median	7775	SD of log Data	0.1672954
SD	1386.5175		
Coefficient of Variation	0.1727502		
Skewness	0.9286032		

Log-transformed Statistics

Warning: A sample size of 'n' = 7 may not adequate enough to compute meaningful and reliable test statistics and estimates!

It is suggested to collect at least 8 to 10 observations using these statistical methods!

If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Warning: There are only 7 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set, the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic
Shapiro Wilk Critical Value

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

0.9439266	Shapiro Wilk Test Statistic	0.9727081
0.803	Shapiro Wilk Critical Value	0.803

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL

95% Modified-t UCL

Assuming Lognormal Distribution

9,044.47 95% H-UCL

95% Chebyshev (MVUE) UCL

9,084.67 97.5% Chebyshev (MVUE) UCL

9,075.13 99% Chebyshev (MVUE) UCL

9,182.28

10,237.38

11,195.04

13,076.19

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Gamma Distribution Test

k star (bias corrected)
 Theta Star
 nu star
 Approximate Chi Square Value (.05)
 Adjusted Level of Significance
 Adjusted Chi Square Value

Data Distribution
 23.561469 Data appear Normal at 5% Significance Level
 340.64697
 329.86056

Nonparametric Statistics

Anderson-Darling Test Statistic
 Anderson-Darling 5% Critical Value
 Kolmogorov-Smirnov Test Statistic
 Kolmogorov-Smirnov 5% Critical Value

288.77964
 0.01584 95% CLT UCL 8,888.14
 277.10958 95% Jackknife UCL 9,044.47
 95% Standard Bootstrap UCL 8,816.90
 0.2234529 95% Bootstrap-t UCL 9,337.83
 0.7073752 95% Hall's Bootstrap UCL 9,859.52
 0.1552418 95% Percentile Bootstrap UCL 8,848.86
 0.3114179 95% BCA Bootstrap UCL 8,996.57
 95% Chebyshev(Mean, Sd) UCL 10,310.44
 97.5% Chebyshev(Mean, Sd) UCL 11,298.86
 99% Chebyshev(Mean, Sd) UCL 13,240.42

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL 9,167.92
 95% Adjusted Gamma UCL 9,554.01

Potential UCL to Use

Use 95% Student's-t UCL 9,044.47

Antimony (mg/kg)**General Statistics**

Number of Valid Data
 Number of Distinct Detected Data

5 Number of Detected Data 1
 1 Number of Non-Detect Data 4
 Percent Non-Detects 80.00%

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPA)

The data set for variable Antimony (mg/kg) was not processed!

Arsenic (MG/KG)**General Statistics**

Number of Valid Observations

7 Number of Distinct Observations 7

Raw Statistics

Minimum
 Maximum
 Mean
 Median
 SD
 Coefficient of Variation
 Skewness

Log-transformed Statistics

5.12 Minimum of Log Data 1.6331544
 16.5 Maximum of Log Data 2.8033604
 10.412454 Mean of log Data 2.2507936
 11 SD of log Data 0.4792244
 4.5189976
 0.4339993
 -0.008032

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St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Warning: A sample size of 'n' = 7 may not adequate enough to compute meaningful and reliable test statistics and estimates!

It is suggested to collect at least 8 to 10 observations using these statistical methods!

If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Warning: There are only 7 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set, the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic

0.9167942 Shapiro Wilk Test Statistic

0.8909708

Shapiro Wilk Critical Value

0.803 Shapiro Wilk Critical Value

0.803

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL

13.731445

95% H-UCL

17.091387

95% UCLs (Adjusted for Skewness)

95% Chebyshev (MVUE) UCL

18.765503

95% Adjusted-CLT UCL

13.216358

97.5% Chebyshev (MVUE) UCL

22.357132

95% Modified-t UCL

13.730581

99% Chebyshev (MVUE) UCL

29.412192

Gamma Distribution Test

k star (bias corrected)

3.2859826

Data Distribution

Data appear Normal at 5% Significance Level

Theta Star

3.1687491

nu star

46.003756

Approximate Chi Square Value (.05)

31.442161

Adjusted Level of Significance

0.01584

Adjusted Chi Square Value

27.856215

Nonparametric Statistics

95% CLT UCL

13.221898

95% Jackknife UCL

13.731445

95% Standard Bootstrap UCL

12.996355

95% Bootstrap-t UCL

13.629527

95% Hall's Bootstrap UCL

12.661153

95% Percentile Bootstrap UCL

12.969597

95% BCA Bootstrap UCL

12.969597

Anderson-Darling Test Statistic

0.3915268

Anderson-Darling 5% Critical Value

0.7096989

Kolmogorov-Smirnov Test Statistic

0.1974979

Kolmogorov-Smirnov 5% Critical Value

0.3128839

Data appear Gamma Distributed at 5% Significance Level

95% Chebyshev(Mean, Sd) UCL

17.857543

97.5% Chebyshev(Mean, Sd) UCL

21.079039

99% Chebyshev(Mean, Sd) UCL

27.407044

Assuming Gamma Distribution

95% Approximate Gamma UCL

15.234704

95% Adjusted Gamma UCL

17.195876

Potential UCL to Use

Use 95% Student's-t UCL

13.731445

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Chromium (mg/kg)**General Statistics**

Number of Valid Data	9 Number of Detected Data	8
Number of Distinct Detected Data	8 Number of Non-Detect Data	1
	Percent Non-Detects	11.11%

Raw Statistics

Minimum Detected	13 Minimum Detected	2.5649494
Maximum Detected	57.7 Maximum Detected	4.0552572
Mean of Detected	21.78425 Mean of Detected	2.9565933
SD of Detected	14.757318 SD of Detected	0.4722927
Minimum Non-Detect	12.7 Minimum Non-Detect	2.541602
Maximum Non-Detect	12.7 Maximum Non-Detect	2.541602

Log-transformed Statistics

Warning: There are only 8 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics**Normal Distribution Test with Detected Values Only**

Shapiro Wilk Test Statistic
 5% Shapiro Wilk Critical Value
Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

0.590568 Shapiro Wilk Test Statistic
 0.818 5% Shapiro Wilk Critical Value
Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method	DL/2 Substitution Method	
Mean	20.069333 Mean	2.8334668
SD	14.731754 SD	0.5758638
95% DL/2 (t) UCL	29.200802 95% H-Stat (DL/2) UCL	21.149666

Assuming Lognormal Distribution**Maximum Likelihood Estimate(MLE) Method**

Mean	19.739041 Mean in Log Scale	2.8428367
SD	14.461512 SD in Log Scale	0.5582498
95% MLE (t) UCL	28.702999 Mean in Original Scale	20.131413
95% MLE (Tiku) UCL	28.195649 SD in Original Scale	14.667752
	95% Percentile Bootstrap UCL	29.272
	95% BCA Bootstrap UCL	33.300969

Log ROS Method**Gamma Distribution Test with Detected Values Only**

k star (bias corrected) 2.6911067
 Theta Star 8.0949038
 nu star 43.057707

Data Distribution Test with Detected Values Only

Data do not follow a Discernable Distribution (0.05)

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A-D Test Statistic	1.1543561	Nonparametric Statistics	
5% A-D Critical Value	0.7186562	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.7186562	Mean	20.808222
5% K-S Critical Value	0.2953145	SD	13.304295
Data not Gamma Distributed at 5% Significance Level		SE of Mean	4.7409633
		95% KM (t) UCL	29.624271
Assuming Gamma Distribution		95% KM (z) UCL	28.606413
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	29.484516
Minimum	4.8356433	95% KM (bootstrap t) UCL	53.791583
Maximum	57.7	95% KM (BCA) UCL	30.938667
Mean	19.901071	95% KM (Percentile Bootstrap) UCL	29.819333
Median	15.7	95% KM (Chebyshev) UCL	41.473602
SD	14.915542	97.5% KM (Chebyshev) UCL	50.415529
k star	1.9548467	99% KM (Chebyshev) UCL	67.980212
Theta star	10.180375		
Nu star	35.18724	Potential UCLs to Use	
AppChi2	22.615366	95% KM (Chebyshev) UCL	41.473602
95% Gamma Approximate UCL	30.96407		
95% Adjusted Gamma UCL	34.134802		

Note: DL/2 is not a recommended method.

Iron (mg/kg)

General Statistics

Number of Valid Observations	7	Number of Distinct Observations	7
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Raw Statistics

Minimum	5,800	Minimum of Log Data	8.6656132
Maximum	17,300	Maximum of Log Data	9.7584618
Mean	13,810	Mean of log Data	9.4841194
Median	14,793	SD of log Data	0.3743007
SD	3,833.40		
Coefficient of Variation	0.2775814		
Skewness	-1.851035		

Log-transformed Statistics

Warning: A sample size of 'n' = 7 may not adequate enough to compute meaningful and reliable test statistics and estimates!

It is suggested to collect at least 8 to 10 observations using these statistical methods!

If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Warning: There are only 7 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set, the resulting calculations may not be reliable enough to draw conclusions

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The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics**Normal Distribution Test**

Shapiro Wilk Test Statistic

0.815815 Shapiro Wilk Test Statistic

0.7068648

Shapiro Wilk Critical Value

0.803 Shapiro Wilk Critical Value

0.803

Data appear Normal at 5% Significance Level**Lognormal Distribution Test****Data not Lognormal at 5% Significance Level****Assuming Normal Distribution**

95% Student's-t UCL

16,625.45

Assuming Lognormal Distribution

95% H-UCL

19,980.69

95% UCLs (Adjusted for Skewness)

95% Chebyshev (MVUE) UCL

22,590.59

95% Adjusted-CLT UCL

15,110.08

97.5% Chebyshev (MVUE) UCL

26,326.45

95% Modified-t UCL

16,456.50

99% Chebyshev (MVUE) UCL

33,664.83

Gamma Distribution Test

k star (bias corrected)

6.0163534

Data Distribution**Data appear Normal at 5% Significance Level**

Theta Star

2,295.41

nu star

84.228947

Approximate Chi Square Value (.05)

64.076113

Nonparametric Statistics

Adjusted Level of Significance

0.01584

95% CLT UCL

16,193.21

Adjusted Chi Square Value

58.793507

95% Jackknife UCL

16,625.45

95% Standard Bootstrap UCL

15,973.40

Anderson-Darling Test Statistic

0.8692685

95% Bootstrap-t UCL

15,777.59

Anderson-Darling 5% Critical Value

0.7084148

95% Hall's Bootstrap UCL

15,443.15

Kolmogorov-Smirnov Test Statistic

0.3157855

95% Percentile Bootstrap UCL

15,811

Kolmogorov-Smirnov 5% Critical Value

0.311913

95% BCA Bootstrap UCL

15,466

Data not Gamma Distributed at 5% Significance Level

95% Chebyshev(Mean, Sd) UCL

20,125.56

97.5% Chebyshev(Mean, Sd) UCL

22,858.31

99% Chebyshev(Mean, Sd) UCL

28,226.26

Assuming Gamma Distribution

95% Approximate Gamma UCL

18,153.44

95% Adjusted Gamma UCL

19,784.53

Potential UCL to Use

Use 95% Student's-t UCL

16,625.45

Manganese (mg/kg)**General Statistics**

Number of Valid Observations

7 Number of Distinct Observations

7

Raw Statistics

Minimum

509 Minimum of Log Data

6.232448

Maximum

1060 Maximum of Log Data

6.9660242

Mean

688.65286 Mean of log Data

6.5002259

Median

619 SD of log Data

0.2750588

SD

207.67682

Log-transformed Statistics

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Coefficient of Variation	0.3015697
Skewness	1.280718

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If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Warning: There are only 7 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set, the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics**Normal Distribution Test**

Shapiro Wilk Test Statistic	0.8122081
Shapiro Wilk Critical Value	0.803

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.8524582
Shapiro Wilk Critical Value	0.803

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	841.18169
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95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL	858.36456
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95% Modified-t UCL	847.51444
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Assuming Lognormal Distribution

95% H-UCL	879.45874
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95% Chebyshev (MVUE) UCL	999.08378
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97.5% Chebyshev (MVUE) UCL	1,134.07
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99% Chebyshev (MVUE) UCL	1,399.22
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Gamma Distribution Test

k star (bias corrected)	8.4681966
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Theta Star	81.322256
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nu star	118.55475
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Approximate Chi Square Value (.05)	94.413606
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Adjusted Level of Significance	0.01584
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Adjusted Chi Square Value	87.916408
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Anderson-Darling Test Statistic	0.6401328
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Anderson-Darling 5% Critical Value	0.7076425
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Kolmogorov-Smirnov Test Statistic	0.3258367
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Kolmogorov-Smirnov 5% Critical Value	0.3117113
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Data follow Appr. Gamma Distribution at 5% Significance Level

Data Distribution

Data appear Normal at 5% Significance Level

Nonparametric Statistics

95% CLT UCL	817.76476
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95% Jackknife UCL	841.18169
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95% Standard Bootstrap UCL	811.87861
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95% Bootstrap-t UCL	1261.2104
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95% Hall's Bootstrap UCL	1799.1471
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95% Percentile Bootstrap UCL	816.42857
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95% BCA Bootstrap UCL	832.85714
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95% Chebyshev(Mean, Sd) UCL	1,030.80
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97.5% Chebyshev(Mean, Sd) UCL	1,178.85
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99% Chebyshev(Mean, Sd) UCL	1,469.66
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Assuming Gamma Distribution

95% Approximate Gamma UCL	864.73839
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95% Adjusted Gamma UCL	928.64427
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Potential UCL to Use

Use 95% Student's-t UCL

841.18169

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ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit E
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Thallium (mg/kg)

General Statistics

Number of Valid Data	5	Number of Detected Data	1
Number of Distinct Detected Data	1	Number of Non-Detect Data	4
		Percent Non-Detects	80.00%

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPA)

The data set for variable Thallium (mg/kg) was not processed!

Vanadium (mg/kg)

General Statistics

Number of Valid Observations	6	Number of Distinct Observations	6
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Raw Statistics

Minimum	20.3	Minimum of Log Data	3.0106209
Maximum	44.1	Maximum of Log Data	3.7864598
Mean	27.003667	Mean of log Data	3.2610068
Median	24.75	SD of log Data	0.2751648
SD	8.6728773		
Coefficient of Variation	0.3211741		
Skewness	2.0794264		

Log-transformed Statistics

Warning: A sample size of 'n' = 6 may not adequate enough to compute meaningful and reliable test statistics and estimates!

It is suggested to collect at least 8 to 10 observations using these statistical methods!
If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Warning: There are only 6 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set, the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic
Shapiro Wilk Critical Value

Data not Normal at 5% Significance Level

Lognormal Distribution Test

0.7408351 Shapiro Wilk Test Statistic
0.788 Shapiro Wilk Critical Value

Data appear Lognormal at 5% Significance Level

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ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit E
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Assuming Normal Distribution

95% Student's-t UCL
95% UCLs (Adjusted for Skewness)
95% Adjusted-CLT UCL
95% Modified-t UCL

34.138323
36.039286
34.639284

Assuming Lognormal Distribution

95% H-UCL
95% Chebyshev (MVUE) UCL
97.5% Chebyshev (MVUE) UCL
99% Chebyshev (MVUE) UCL

35.433147
40.081622
45.78197
56.979198

Gamma Distribution Test

k star (bias corrected)
Theta Star
nu star
Approximate Chi Square Value (.05)
Adjusted Level of Significance
Adjusted Chi Square Value

7.3432913
3.6773247
88.119496

Data Distribution

Data appear Gamma Distributed at 5% Significance Level

67.477896

Nonparametric Statistics

95% CLT UCL
95% Jackknife UCL
95% Standard Bootstrap UCL
95% Bootstrap-t UCL
95% Hall's Bootstrap UCL
95% Percentile Bootstrap UCL
95% BCA Bootstrap UCL
95% Chebyshev(Mean, Sd) UCL
97.5% Chebyshev(Mean, Sd) UCL
99% Chebyshev(Mean, Sd) UCL

32.827579
34.138323
32.389343
45.407855
60.167825
33.35
34.703667
42.437165
49.115252
62.233061

Anderson-Darling Test Statistic
Anderson-Darling 5% Critical Value
Kolmogorov-Smirnov Test Statistic
Kolmogorov-Smirnov 5% Critical Value

0.6762006
0.6977764
0.3311688
0.3321452

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL
95% Adjusted Gamma UCL

35.264133
39.017232

Potential UCL to Use

Use 95% Approximate Gamma UCL

35.264133

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit F

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Summary Statistics for Raw Data Sets with NDs using Detected Data Only

				Raw Statistics using Detected Observations							
Variable	Num Ds	NumNDs	% NDs	Minimum	Maximum	Mean	Median	SD	MAD/0.675	Skewness	CV
Aluminum (mg/kg)	11	0	0.00%	6,464.20	11,100	8,486.15	8,492	1,511.22	2,057.38	0.267543	0.178081
Antimony (mg/kg)	2	2	50.00%	2.2	5.73	3.965	3.965	2.496087	2.616753	N/A	0.62953
Arsenic (mg/kg)	11	3	21.43%	4.93	14.5	7.77696	7.4	2.750578	2.745502	1.512119	0.353683
Iron (mg/kg)	11	0	0.00%	13,429	18,600	15,736.36	15,605	1,449.05	1,178.65	0.546727	0.092083
Lead (mg/kg)	16	0	0.00%	11.9	1,118	136.45488	50.1	281.0802	32.31134	3.300537	2.059877
Manganese (mg/kg)	11	0	0.00%	516	1,025.30	693.59455	639	144.9319	51.43069	1.388172	0.208958
Thallium (mg/kg)	2	3	60.00%	0.3	2.18	1.24	1.24	1.329361	1.393625	N/A	1.072065
Vanadium (mg/kg)	8	0	0.00%	22.045	46.1	26.088875	22.9615	8.173508	1.00593	2.714146	0.313295

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ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit F
 St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

General UCL Statistics for Data Sets with Non-Detects**User Selected Options**

Full Precision	ON	
Confidence Coefficient	95%	
Number of Bootstrap Operations		2,000

Aluminum (mg/kg)**General Statistics**

Number of Valid Observations	11	Number of Distinct Observations	10
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Raw Statistics

Minimum	6,464.20
Maximum	11,100
Mean	8,486.15
Median	8,492
SD	1,511.22
Coefficient of Variation	0.1780805
Skewness	0.2675428

Log-transformed Statistics

Minimum of Log Data	8.7740345
Maximum of Log Data	9.3147004
Mean of log Data	9.0317612
SD of log Data	0.1783572

Relevant UCL Statistics**Normal Distribution Test**

Shapiro Wilk Test Statistic	0.9402191
Shapiro Wilk Critical Value	0.85

Data appear Normal at 5% Significance Level**Lognormal Distribution Test**

Shapiro Wilk Test Statistic	0.9403783
Shapiro Wilk Critical Value	0.85

Data appear Lognormal at 5% Significance Level**Assuming Normal Distribution**

95% Student's-t UCL	9,311.99
95% UCLs (Adjusted for Skewness)	
95% Adjusted-CLT UCL	9,274.90
95% Modified-t UCL	9,318.12

Assuming Lognormal Distribution

95% H-UCL	9,429.57
95% Chebyshev (MVUE) UCL	10,481.40
97.5% Chebyshev (MVUE) UCL	11,344.70
99% Chebyshev (MVUE) UCL	13,040.48

Gamma Distribution Test

k star (bias corrected)	25.383021
Theta Star	334.3237
nu star	558.42646
Approximate Chi Square Value (.05)	504.61681
Adjusted Level of Significance	0.02783
Adjusted Chi Square Value	496.26783

Data Distribution**Data appear Normal at 5% Significance Level****Nonparametric Statistics**

Anderson-Darling Test Statistic	0.3508898	95% CLT UCL	9,235.62
Anderson-Darling 5% Critical Value	0.7285518	95% Jackknife UCL	9,311.99
Kolmogorov-Smirnov Test Statistic	0.1954249	95% Standard Bootstrap UCL	9,196.95
Kolmogorov-Smirnov 5% Critical Value	0.2548423	95% Bootstrap-t UCL	9,356.77
		95% Hall's Bootstrap UCL	9,289.58
		95% Percentile Bootstrap UCL	9,197.14
		95% BCA Bootstrap UCL	9,238.66
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	10,472.27
		97.5% Chebyshev(Mean, Sd) UCL	11,331.67

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ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit F
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	13,019.80
95% Approximate Gamma UCL	9,391.06		
95% Adjusted Gamma UCL	9,549.05		
Potential UCL to Use		Use 95% Student's-t UCL	9,311.99

Antimony (mg/kg)**General Statistics**

Number of Valid Data	4	Number of Detected Data	2
Number of Distinct Detected Data	2	Number of Non-Detect Data	2
		Percent Non-Detects	50.00%

Warning: This data set only has 4 observations!

Data set is too small to compute reliable and meaningful statistics and estimates!

The data set for variable Antimony (mg/kg) was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!

If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Arsenic (MG/KG)**General Statistics**

Number of Valid Data	14	Number of Detected Data	11
Number of Distinct Detected Data	11	Number of Non-Detect Data	3
		Percent Non-Detects	21.43%

Raw Statistics

Minimum Detected
Maximum Detected
Mean of Detected
SD of Detected
Minimum Non-Detect
Maximum Non-Detect

Log-transformed Statistics

4.93	Minimum Detected	1.595339
14.5	Maximum Detected	2.6741486
7.77696	Mean of Detected	2.0018497
2.7505779	SD of Detected	0.3203052
0.25	Minimum Non-Detect	-1.386294
1.376	Maximum Non-Detect	0.3191807

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Number treated as Non-Detect

Number treated as Detected

Single DL Non-Detect Percentage

3
11
21.43%

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit F
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic
5% Shapiro Wilk Critical Value
Data appear Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

0.861705 Shapiro Wilk Test Statistic
0.85 5% Shapiro Wilk Critical Value
Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean 6.2176829
SD 3.9289571
95% DL/2 (t) UCL 8.0772655

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean 1.3709266
SD 1.3416122
95% H-Stat (DL/2) UCL 13.361084

Maximum Likelihood Estimate(MLE) Method

Mean 5.9280517
SD 4.3258153
95% MLE (t) UCL 7.975468
95% MLE (Tiku) UCL 8.1007181

Log ROS Method

Mean in Log Scale 1.838564
SD in Log Scale 0.4308135
Mean in Original Scale 6.8530829
SD in Original Scale 3.034262
95% Percentile Bootstrap UCL 8.1519773
95% BCA Bootstrap UCL 8.4386802

Gamma Distribution Test with Detected Values Only

k star (bias corrected) 7.5534075
Theta Star 1.0295962
nu star 166.17497

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

A-D Test Statistic

5% A-D Critical Value

K-S Test Statistic

5% K-S Critical Value

Nonparametric Statistics

0.7293497 Kaplan-Meier (KM) Method

0.7293497 Mean

0.2553694 SD

Data appear Gamma Distributed at 5% Significance Level

SE of Mean

95% KM (t) UCL

95% KM (z) UCL

95% KM (jackknife) UCL

95% KM (bootstrap t) UCL

95% KM (BCA) UCL

95% KM (Percentile Bootstrap) UCL

95% KM (Chebyshev) UCL

97.5% KM (Chebyshev) UCL

99% KM (Chebyshev) UCL

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum

Maximum

Mean

Median

SD

k star

Theta star

Nu star

AppChi2

95% Gamma Approximate UCL

95% Adjusted Gamma UCL

3.8060056

14.5

7.0985675

6.7998225

2.780161

6.5580826

1.0824151

183.62631

153.28189

8.5038341

8.7128073

Potential UCLs to Use

95% KM (t) UCL

95% KM (Percentile Bootstrap) UCL

Note: DL/2 is not a recommended method.

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit F
 St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Iron (mg/kg)**General Statistics**

Number of Valid Observations	11	Number of Distinct Observations	11
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Raw Statistics

Minimum	13,429	Minimum of Log Data	9.5051718
Maximum	18,600	Maximum of Log Data	9.8309169
Mean	15,736.36	Mean of log Data	9.6599421
Median	15,605	SD of log Data	0.0909432
SD	1,449.05		
Coefficient of Variation	0.0920831		
Skewness	0.5467273		

Log-transformed Statistics**Relevant UCL Statistics****Normal Distribution Test**

Shapiro Wilk Test Statistic	0.9733526	Shapiro Wilk Test Statistic	0.9840889
Shapiro Wilk Critical Value	0.85	Shapiro Wilk Critical Value	0.85

Data appear Normal at 5% Significance Level**Lognormal Distribution Test****Data appear Lognormal at 5% Significance Level****Assuming Normal Distribution**

95% Student's-t UCL	16,528.24	95% H-UCL	N/A
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	17,618.17
95% Adjusted-CLT UCL	16,531.97	97.5% Chebyshev (MVUE) UCL	18,432.63
95% Modified-t UCL	16,540.24	99% Chebyshev (MVUE) UCL	20,032.47

Assuming Lognormal Distribution**Gamma Distribution Test**

k star (bias corrected)	96.194664	Data appear Normal at 5% Significance Level	
Theta Star	163.58874		
nu star	2,116.28		
Approximate Chi Square Value (.05)	2,010.42	Nonparametric Statistics	
Adjusted Level of Significance	0.02783	95% CLT UCL	16,455.01
Adjusted Chi Square Value	1,993.57	95% Jackknife UCL	16,528.24
		95% Standard Bootstrap UCL	16,444.81
Anderson-Darling Test Statistic	0.1767039	95% Bootstrap-t UCL	16,635.80
Anderson-Darling 5% Critical Value	0.72567	95% Hall's Bootstrap UCL	16,803.20
Kolmogorov-Smirnov Test Statistic	0.1242228	95% Percentile Bootstrap UCL	16,443.36
Kolmogorov-Smirnov 5% Critical Value	0.25443	95% BCA Bootstrap UCL	16,484.36
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	17,640.79
		97.5% Chebyshev(Mean, Sd) UCL	18,464.84
		99% Chebyshev(Mean, Sd) UCL	20,083.52
Assuming Gamma Distribution			
95% Approximate Gamma UCL	16,564.99		
95% Adjusted Gamma UCL	16,705.03		

Potential UCL to Use

Use 95% Student's-t UCL	16528.239
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APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit F
 St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Lead (mg/kg)**General Statistics**

Number of Valid Observations	16	Number of Distinct Observations	16
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Raw Statistics

Minimum	11.9	Minimum of Log Data	2.4765384
Maximum	1118	Maximum of Log Data	7.0192967
Mean	136.45488	Mean of log Data	3.9801034
Median	50.1	SD of log Data	1.1961143
SD	281.08024		
Coefficient of Variation	2.0598769		
Skewness	3.3005368		

Log-transformed Statistics**Relevant UCL Statistics****Normal Distribution Test**

Shapiro Wilk Test Statistic	0.460115	Shapiro Wilk Test Statistic	0.8711778
Shapiro Wilk Critical Value	0.887	Shapiro Wilk Critical Value	0.887

Data not Normal at 5% Significance Level**Lognormal Distribution Test****Data not Lognormal at 5% Significance Level****Assuming Normal Distribution**

95% Student's-t UCL	259.64182	95% H-UCL	277.97708
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	251.83154
95% Adjusted-CLT UCL	313.99369	97.5% Chebyshev (MVUE) UCL	316.5961
95% Modified-t UCL	269.30553	99% Chebyshev (MVUE) UCL	443.81353

Assuming Lognormal Distribution**Gamma Distribution Test**

k star (bias corrected)	0.5716053	Data do not follow a Discernable Distribution (0.05)
Theta Star	238.72219	
nu star	18.29137	

Approximate Chi Square Value (.05)

Adjusted Level of Significance	0.03348	95% CLT UCL	252.03884
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Adjusted Chi Square Value	8.8914769	95% Jackknife UCL	259.64182
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Anderson-Darling Test Statistic	1.883007	95% Standard Bootstrap UCL	249.61639
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Anderson-Darling 5% Critical Value	0.7830532	95% Bootstrap-t UCL	1,295.54
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Kolmogorov-Smirnov Test Statistic	0.3339443	95% Hall's Bootstrap UCL	961.65134
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Kolmogorov-Smirnov 5% Critical Value	0.2247765	95% Percentile Bootstrap UCL	257.30881
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		95% BCA Bootstrap UCL	341.58963
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Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	442.75497
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Assuming Gamma Distribution

95% Approximate Gamma UCL	259.94658	97.5% Chebyshev(Mean, Sd) UCL	575.29126
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95% Adjusted Gamma UCL	280.71226	99% Chebyshev(Mean, Sd) UCL	835.63315
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Potential UCL to Use

Use 99% Chebyshev (Mean, Sd) UCL	835.63315
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APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit F
 St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Manganese (mg/kg)**General Statistics**

Number of Valid Observations

11 Number of Distinct Observations

11

Raw Statistics

Minimum

516 Minimum of Log Data

6.2461068

Maximum

1,025.30 Maximum of Log Data

6.9327405

Mean

693.59455 Mean of log Data

6.5240985

Median

639 SD of log Data

0.1928534

SD

144.93189

Coefficient of Variation

0.2089577

Skewness

1.3881722

Log-transformed Statistics**Relevant UCL Statistics****Normal Distribution Test**

Shapiro Wilk Test Statistic

0.8490148 Shapiro Wilk Test Statistic

0.8964185

Shapiro Wilk Critical Value

0.85 Shapiro Wilk Critical Value

0.85

Data not Normal at 5% Significance Level**Lognormal Distribution Test****Data appear Lognormal at 5% Significance Level****Assuming Normal Distribution**

95% Student's-t UCL

772.79657 95% H-UCL

777.26192

95% UCLs (Adjusted for Skewness)

95% Chebyshev (MVUE) UCL

869.21162

95% Adjusted-CLT UCL

785.01553 97.5% Chebyshev (MVUE) UCL

945.4734

95% Modified-t UCL

775.84491 99% Chebyshev (MVUE) UCL

1,095.27

Assuming Lognormal Distribution**Gamma Distribution Test**

k star (bias corrected)

20.622619

Theta Star

33.632709

nu star

453.69762

Approximate Chi Square Value (.05)

405.3125

Adjusted Level of Significance

0.02783

Adjusted Chi Square Value

397.84939

Anderson-Darling Test Statistic

0.7153417

Anderson-Darling 5% Critical Value

0.7286173

Kolmogorov-Smirnov Test Statistic

0.2635994

Kolmogorov-Smirnov 5% Critical Value

0.2549252

Data follow Appr. Gamma Distribution at 5% Significance Level**Data Distribution****Data Follow Appr. Gamma Distribution at 5% Significance Level****Nonparametric Statistics**

95% CLT UCL

765.47236

95% Jackknife UCL

772.79657

95% Standard Bootstrap UCL

763.65287

95% Bootstrap-t UCL

821.71649

95% Hall's Bootstrap UCL

902.0437

95% Percentile Bootstrap UCL

765.83727

95% BCA Bootstrap UCL

780.53545

95% Chebyshev(Mean, Sd) UCL

884.07237

97.5% Chebyshev(Mean, Sd) UCL

966.49228

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit F
 St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	1128.3902
95% Approximate Gamma UCL	776.39401		
95% Adjusted Gamma UCL	790.9581		

Potential UCL to Use	Use 95% Approximate Gamma UCL	776.39401
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Thallium (mg/kg)**General Statistics**

Number of Valid Data	5 Number of Detected Data	2
Number of Distinct Detected Data	2 Number of Non-Detect Data	3
	Percent Non-Detects	60.00%

Raw Statistics

Minimum Detected	0.3 Minimum Detected	-1.203973
Maximum Detected	2.18 Maximum Detected	0.7793249
Mean of Detected	1.24 Mean of Detected	-0.212324
SD of Detected	1.3293607 SD of Detected	1.4024032
Minimum Non-Detect	31.3 Minimum Non-Detect	3.4436181
Maximum Non-Detect	31.3 Maximum Non-Detect	3.4436181

Log-transformed Statistics

Warning: Data set has only 2 Distinct Detected Values.

This may not be adequate enough to compute meaningful and reliable test statistics and estimates.

The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

Unless Data Quality Objectives (DQOs) have been met, it is suggested to collect additional observations.

The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.

Those methods will return a 'N/A' value on your output display

It is necessary to have 4 or more Distinct Values for bootstrap methods.

It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

UCL Statistics**Normal Distribution Test with Detected Values Only**

Shapiro Wilk Test Statistic	0.9999808
5% Shapiro Wilk Critical Value	N/A
Data not Normal at 5% Significance Level	

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.9999808
5% Shapiro Wilk Critical Value	N/A
Data not Lognormal at 5% Significance Level	

Assuming Normal Distribution

DL/2 Substitution Method		
Mean	9.886 Mean	1.565353
SD	7.9206206 SD	1.7678037

Assuming Lognormal Distribution

DL/2 Substitution Method		
Mean	9.886 Mean	1.565353
SD	7.9206206 SD	1.7678037

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit F
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

95% DL/2 (t) UCL	17.437444	95% H-Stat (DL/2) UCL	44768162
Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	N/A
		SD in Log Scale	N/A
		Mean in Original Scale	N/A
		SD in Original Scale	N/A
		95% Percentile Bootstrap UCL	N/A
		95% BCA Bootstrap UCL	N/A
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	N/A	Data do not follow a Discernable Distribution (0.05)	
Theta Star	N/A		
nu star	N/A		
A-D Test Statistic	0.3575674	Nonparametric Statistics	
5% A-D Critical Value	N/A	Kaplan-Meier (KM) Method	
K-S Test Statistic	N/A	Mean	1.24
5% K-S Critical Value	N/A	SD	0.94
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.94
		95% KM (t) UCL	3.2439352
Assuming Gamma Distribution		95% KM (z) UCL	2.7861624
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	N/A
Minimum	N/A	95% KM (bootstrap t) UCL	N/A
Maximum	N/A	95% KM (BCA) UCL	N/A
Mean	N/A	95% KM (Percentile Bootstrap) UCL	N/A
Median	N/A	95% KM (Chebyshev) UCL	5.337365
SD	N/A	97.5% KM (Chebyshev) UCL	7.1102981
k star	N/A	99% KM (Chebyshev) UCL	10.592882
Theta star	N/A		
Nu star	N/A	Potential UCLs to Use	
AppChi2	N/A	95% KM (BCA) UCL	N/A
95% Gamma Approximate UCL	N/A		
95% Adjusted Gamma UCL	N/A		

Note: DL/2 is not a recommended method.

Vanadium (mg/kg)

General Statistics

Number of Valid Observations	8	Number of Distinct Observations	8
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Raw Statistics

Minimum	22.045	Minimum of Log Data	3.0930858
Maximum	46.1	Maximum of Log Data	3.830813
Mean	26.088875	Mean of log Data	3.2300135
Median	22.9615	SD of log Data	0.2478085

Log-transformed Statistics

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit F
 St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

SD	8.1735083
Coefficient of Variation	0.3132948
Skewness	2.7141459

Warning: There are only 8 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set, the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics**Normal Distribution Test**

Shapiro Wilk Test Statistic
 Shapiro Wilk Critical Value

Lognormal Distribution Test

0.5386111 Shapiro Wilk Test Statistic
 0.818 Shapiro Wilk Critical Value

0.5845799
 0.818

Data not Normal at 5% Significance Level

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL
95% UCLs (Adjusted for Skewness)
 95% Adjusted-CLT UCL
 95% Modified-t UCL

Assuming Lognormal Distribution

31.563774	95% H-UCL	31.425164
	95% Chebyshev (MVUE) UCL	35.911055
33.80513	97.5% Chebyshev (MVUE) UCL	40.21415
32.025943	99% Chebyshev (MVUE) UCL	48.666748

Gamma Distribution Test

k star (bias corrected)
 Theta Star
 nu star
 Approximate Chi Square Value (.05)
 Adjusted Level of Significance
 Adjusted Chi Square Value

Data Distribution
Data do not follow a Discernable Distribution (0.05)

10.108437
 2.5809009
 161.735

Nonparametric Statistics

0.01946	95% CLT UCL	30.842126
126.80377	95% Jackknife UCL	31.563774
	95% Standard Bootstrap UCL	30.416254
1.6753816	95% Bootstrap-t UCL	76.104353
0.7157371	95% Hall's Bootstrap UCL	54.913755
0.3658348	95% Percentile Bootstrap UCL	31.639125
0.2940263	95% BCA Bootstrap UCL	34.443125
	95% Chebyshev(Mean, Sd) UCL	38.685097
	97.5% Chebyshev(Mean, Sd) UCL	44.135493
	99% Chebyshev(Mean, Sd) UCL	54.841739

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL
 95% Adjusted Gamma UCL

31.646512
 33.275699

Potential UCL to Use

Use 95% Student's-t UCL	31.563774
or 95% Modified-t UCL	32.025943

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit G

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Summary Statistics for Raw Data Sets with NDs using Detected Data Only

				Raw Statistics using Detected Observations							
Variable	Num Ds	NumNDs	% NDs	Minimum	Maximum	Mean	Median	SD	MAD/0.675	Skewness	CV
Aluminum (mg/kg)	11	0	0.00%	6,837.10	14,655	9,527.92	8,710	2,543.43	2,495.18	0.850085	0.266945
Benzo(b)fluoranthene (mg/kg)	2	1	33.33%	0.1298	0.8186	0.4742	0.4742	0.487055	0.5106	N/A	1.027109
Iron (mg/kg)	11	0	0.00%	6,000	22,519	16,224.09	16,074	4,073.70	1,444.03	-1.384002	0.25109
Lead (mg/kg)	12	0	0.00%	11	983	133.457	57.9	270.2262	55.22609	3.343343	2.024818
Manganese (mg/kg)	11	0	0.00%	601	1,070	814.05364	766.83	160.4565	124.2847	0.516657	0.197108
Thallium (mg/kg)	2	5	71.43%	1.94	5.19	3.565	3.565	2.298097	2.409192	N/A	0.644628
Vanadium (mg/kg)	9	0	0.00%	22.2	50.2	31.372667	27.9	9.338842	5.337287	1.273469	0.297675

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit G

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

General UCL Statistics for Data Sets with Non-Detects**User Selected Options**

Full Precision	ON	
Confidence Coefficient	95%	
Number of Bootstrap Operations		2,000

Aluminum (mg/kg)**General Statistics**

Number of Valid Observations	11	Number of Distinct Observations	11
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Raw Statistics

Minimum	6,837.10	Minimum of Log Data	8.8301189
Maximum	14,655	Maximum of Log Data	9.5925369
Mean	9,527.92	Mean of log Data	9.1316206
Median	8710	SD of log Data	0.2545874
SD	2,543.43		
Coefficient of Variation	0.2669446		
Skewness	0.850085		

Log-transformed Statistics**Relevant UCL Statistics****Normal Distribution Test**

Shapiro Wilk Test Statistic	0.8929321	Shapiro Wilk Test Statistic	0.9200134
Shapiro Wilk Critical Value	0.85	Shapiro Wilk Critical Value	0.85

Data appear Normal at 5% Significance Level**Lognormal Distribution Test****Data appear Lognormal at 5% Significance Level****Assuming Normal Distribution**

95% Student's-t UCL	10,917.84	95% H-UCL	11,131.38
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	12,722.49
95% Adjusted-CLT UCL	10,999.33	97.5% Chebyshev (MVUE) UCL	14,108.79
95% Modified-t UCL	10,950.60	99% Chebyshev (MVUE) UCL	16,831.91

Assuming Lognormal Distribution**Gamma Distribution Test**

k star (bias corrected)	12.157698	Data appear Normal at 5% Significance Level
Theta Star	783.69428	
nu star	267.46935	

Approximate Chi Square Value (.05)

230.59644

Adjusted Level of Significance

0.02783

Adjusted Chi Square Value

225.01268

Anderson-Darling Test Statistic

0.4571009

Anderson-Darling 5% Critical Value

0.7289256

Kolmogorov-Smirnov Test Statistic

0.2083565

Kolmogorov-Smirnov 5% Critical Value

0.2551478

Data appear Gamma Distributed at 5% Significance Level**Data Distribution****Data appear Normal at 5% Significance Level****Nonparametric Statistics**

95% CLT UCL	10,789.31
95% Jackknife UCL	10,917.84
95% Standard Bootstrap UCL	10,740.38
95% Bootstrap-t UCL	11,379.31
95% Hall's Bootstrap UCL	10,948.57
95% Percentile Bootstrap UCL	10,739.91
95% BCA Bootstrap UCL	10,897.18
95% Chebyshev(Mean, Sd) UCL	12,870.64

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit G
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Assuming Gamma Distribution		97.5% Chebyshev(Mean, Sd) UCL	14317.032
		99% Chebyshev(Mean, Sd) UCL	17158.198
95% Approximate Gamma UCL	11,051.46		
95% Adjusted Gamma UCL	11,325.70		
Potential UCL to Use	Use 95% Student's-t UCL		10,917.84

Benzo(b)fluoranthene (mg/kg)**General Statistics**

Number of Valid Data	3	Number of Detected Data	2
Number of Distinct Detected Data	2	Number of Non-Detect Data	1
		Percent Non-Detects	33.33%

Warning: This data set only has 3 observations!

Data set is too small to compute reliable and meaningful statistics and estimates!

The data set for variable Benzo(b)fluoranthene (mg/kg) was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!

If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Iron (mg/kg)**General Statistics**

Number of Valid Observations	11	Number of Distinct Observations	11
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Raw Statistics

Minimum	6,000	Minimum of Log Data	8.6995147
Maximum	22,519	Maximum of Log Data	10.022115
Mean	16,224.09	Mean of log Data	9.6522133
Median	16,074	SD of log Data	0.339072
SD	4,073.70		
Coefficient of Variation	0.2510897		
Skewness	-1.384002		

Log-transformed Statistics**Relevant UCL Statistics****Normal Distribution Test**

Shapiro Wilk Test Statistic	0.836104	Shapiro Wilk Test Statistic	0.6871564
Shapiro Wilk Critical Value	0.85	Shapiro Wilk Critical Value	0.85
Data not Normal at 5% Significance Level		Data not Lognormal at 5% Significance Level	

Lognormal Distribution Test

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit G
 St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Assuming Normal Distribution

95% Student's-t UCL 18,450.28
95% UCLs (Adjusted for Skewness)
 95% Adjusted-CLT UCL 17,696.75
 95% Modified-t UCL 18,364.85

Assuming Lognormal Distribution

95% H-UCL 20,391.48
 95% Chebyshev (MVUE) UCL 23,764.81
 97.5% Chebyshev (MVUE) UCL 26,957.17
 99% Chebyshev (MVUE) UCL 33,227.95

Gamma Distribution Test

k star (bias corrected) 8.8300186
 Theta Star 1,837.38
 nu star 194.26041
 Approximate Chi Square Value (.05) 163.015
 Adjusted Level of Significance 0.02783
 Adjusted Chi Square Value 158.34931

Anderson-Darling Test Statistic 1.211324
 Anderson-Darling 5% Critical Value 0.7292321
 Kolmogorov-Smirnov Test Statistic 0.3496137
 Kolmogorov-Smirnov 5% Critical Value 0.255308

Data not Gamma Distributed at 5% Significance Level**Assuming Gamma Distribution**

95% Approximate Gamma UCL 19,333.80
 95% Adjusted Gamma UCL 19,903.46

Data Distribution**Data do not follow a Discernable Distribution (0.05)****Nonparametric Statistics**

95% CLT UCL 18,244.41
 95% Jackknife UCL 18,450.28
 95% Standard Bootstrap UCL 18,140.90
 95% Bootstrap-t UCL 18,079.01
 95% Hall's Bootstrap UCL 17,986.56
 95% Percentile Bootstrap UCL 17,895.09
 95% BCA Bootstrap UCL 17,726.18
 95% Chebyshev(Mean, Sd) UCL 21,577.99
 97.5% Chebyshev(Mean, Sd) UCL 23,894.62
 99% Chebyshev(Mean, Sd) UCL 28,445.20

Potential UCL to Use

Use 95% Student's-t UCL 18,450.28
 or 95% Modified-t UCL 18,364.85

Lead (mg/kg)**General Statistics**

Number of Valid Observations 12 Number of Distinct Observations 12

Raw Statistics

Minimum 11
 Maximum 983
 Mean 133.457
 Median 57.9
 SD 270.22616
 Coefficient of Variation 2.0248181
 Skewness 3.3433429

Log-transformed Statistics

Minimum of Log Data 2.3978953
 Maximum of Log Data 6.8906091
 Mean of log Data 4.0149047
 SD of log Data 1.2012652

Relevant UCL Statistics**Normal Distribution Test**

Shapiro Wilk Test Statistic 0.4533135
 Shapiro Wilk Critical Value 0.859

Data not Normal at 5% Significance Level**Lognormal Distribution Test**

Shapiro Wilk Test Statistic 0.9106411
 Shapiro Wilk Critical Value 0.859

Data appear Lognormal at 5% Significance Level

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit G
 St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Assuming Normal Distribution

95% Student's-t UCL
95% UCLs (Adjusted for Skewness)
 95% Adjusted-CLT UCL
 95% Modified-t UCL

273.54961
 342.2146
 286.09765

Assuming Lognormal Distribution

95% H-UCL
 95% Chebyshev (MVUE) UCL
 97.5% Chebyshev (MVUE) UCL
 99% Chebyshev (MVUE) UCL

375.8374
 274.85561
 348.70825
 493.77746

Gamma Distribution Test

k star (bias corrected)
 Theta Star
 nu star
 Approximate Chi Square Value (.05)
 Adjusted Level of Significance
 Adjusted Chi Square Value

0.5724111
 233.14888
 13.737866
 6.3922696

Data Distribution

Data appear Lognormal at 5% Significance Level

Anderson-Darling Test Statistic
 Anderson-Darling 5% Critical Value
 Kolmogorov-Smirnov Test Statistic
 Kolmogorov-Smirnov 5% Critical Value

1.1518
 0.7703081
 0.2762342
 0.2557521

Nonparametric Statistics

95% CLT UCL
 95% Jackknife UCL
 95% Standard Bootstrap UCL
 95% Bootstrap-t UCL
 95% Hall's Bootstrap UCL
 95% Percentile Bootstrap UCL
 95% BCA Bootstrap UCL
 95% Chebyshev(Mean, Sd) UCL
 97.5% Chebyshev(Mean, Sd) UCL
 99% Chebyshev(Mean, Sd) UCL

261.76804
 273.54961
 257.05181
 909.05316
 835.0536
 283.957
 361.91175
 473.48412
 620.61413
 909.62254

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL
 95% Adjusted Gamma UCL

286.81743
 324.79024

Potential UCL to Use

Use 95% Chebyshev (MVUE) UCL

274.85561

Manganese (mg/kg)**General Statistics**

Number of Valid Observations

11 Number of Distinct Observations

10

Raw Statistics

Minimum
 Maximum
 Mean
 Median
 SD
 Coefficient of Variation
 Skewness

601
 1070
 814.05364
 766.83
 160.4565
 0.197108
 0.5166567

Log-transformed Statistics

Minimum of Log Data
 Maximum of Log Data
 Mean of log Data
 SD of log Data

6.3985949
 6.9754139
 6.6848478
 0.1931167

Relevant UCL Statistics**Normal Distribution Test**

Shapiro Wilk Test Statistic
 Shapiro Wilk Critical Value

0.8952887
 0.85

Lognormal Distribution Test

Shapiro Wilk Test Statistic
 Shapiro Wilk Critical Value

0.9139785
 0.85

Data appear Normal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit G

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Assuming Normal Distribution

95% Student's-t UCL
95% UCLs (Adjusted for Skewness)
 95% Adjusted-CLT UCL
 95% Modified-t UCL

901.73951
 901.68356
 902.99559

Assuming Lognormal Distribution

95% H-UCL
 95% Chebyshev (MVUE) UCL
 97.5% Chebyshev (MVUE) UCL
 99% Chebyshev (MVUE) UCL

913.00809
 1,021.13
 1,110.81
 1,286.99

Gamma Distribution Test

k star (bias corrected)
 Theta Star
 nu star
 Approximate Chi Square Value (.05)
 Adjusted Level of Significance
 Adjusted Chi Square Value

21.34923
 38.130351
 469.68306

Data Distribution**Data appear Normal at 5% Significance Level**

Anderson-Darling Test Statistic
 Anderson-Darling 5% Critical Value
 Kolmogorov-Smirnov Test Statistic
 Kolmogorov-Smirnov 5% Critical Value

420.43218
 0.02783
 412.82769
 0.5474793
 0.7286073
 0.204919
 0.2549126

Nonparametric Statistics

95% CLT UCL
 95% Jackknife UCL
 95% Standard Bootstrap UCL
 95% Bootstrap-t UCL
 95% Hall's Bootstrap UCL
 95% Percentile Bootstrap UCL
 95% BCA Bootstrap UCL
 95% Chebyshev(Mean, Sd) UCL
 97.5% Chebyshev(Mean, Sd) UCL
 99% Chebyshev(Mean, Sd) UCL

893.63076
 901.73951
 890.44788
 919.47269
 888.56844
 894.16
 898.98455
 1,024.93
 1,116.18
 1,295.42

Data appear Gamma Distributed at 5% Significance Level**Assuming Gamma Distribution**

95% Approximate Gamma UCL
 95% Adjusted Gamma UCL

909.4147
 926.16656

Potential UCL to Use

Use 95% Student's-t UCL

901.73951

Thallium (mg/kg)**General Statistics**

Number of Valid Data
 Number of Distinct Detected Data

7 Number of Detected Data
 2 Number of Non-Detect Data
 Percent Non-Detects

2
 5
 71.43%

Raw Statistics

Minimum Detected
 Maximum Detected
 Mean of Detected
 SD of Detected
 Minimum Non-Detect
 Maximum Non-Detect

1.94
 5.19
 3.565
 2.298097
 31.3
 31.3

Log-transformed Statistics

Minimum Detected
 Maximum Detected
 Mean of Detected
 SD of Detected
 Minimum Non-Detect
 Maximum Non-Detect

0.662688
 1.6467337
 1.1547108
 0.6958254
 3.4436181
 3.4436181

Warning: Data set has only 2 Distinct Detected Values.**This may not be adequate enough to compute meaningful and reliable test statistics and estimates.****The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).****Unless Data Quality Objectives (DQOs) have been met, it is suggested to collect additional observations.**

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit G
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.
Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.

It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic 0.9999808
5% Shapiro Wilk Critical Value N/A
Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic 0.9999808
5% Shapiro Wilk Critical Value N/A
Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean 12.197143
SD 5.9710432
95% DL/2 (t) UCL 16.582593

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean 2.2945395
SD 0.8288505
95% H-Stat (DL/2) UCL 289.39638

Maximum Likelihood Estimate(MLE) Method

MLE method failed to converge properly

N/A

Log ROS Method

Mean in Log Scale N/A
SD in Log Scale N/A
Mean in Original Scale N/A
SD in Original Scale N/A
95% Percentile Bootstrap UCL N/A
95% BCA Bootstrap UCL N/A

Gamma Distribution Test with Detected Values Only

k star (bias corrected) N/A
Theta Star N/A
nu star N/A

Data Distribution Test with Detected Values Only

Data do not follow a Discernable Distribution (0.05)

A-D Test Statistic

5% A-D Critical Value N/A
K-S Test Statistic N/A
5% K-S Critical Value N/A

Data not Gamma Distributed at 5% Significance Level

0.3591192

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean 3.565
SD 1.625
SE of Mean 1.625
95% KM (t) UCL 6.7226668
95% KM (z) UCL 6.2378871
95% KM (jackknife) UCL N/A
95% KM (bootstrap t) UCL N/A
95% KM (BCA) UCL N/A
95% KM (Percentile Bootstrap) UCL N/A
95% KM (Chebyshev) UCL 10.648211
97.5% KM (Chebyshev) UCL 13.713122
99% KM (Chebyshev) UCL 19.733546

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum N/A
Maximum N/A
Mean N/A
Median N/A
SD N/A
k star N/A

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit G
 St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Theta star	N/A		
Nu star	N/A	Potential UCLs to Use	
AppChi2	N/A	95% KM (t) UCL	6.7226668
95% Gamma Approximate UCL	N/A	95% KM (% Bootstrap) UCL	N/A
95% Adjusted Gamma UCL	N/A		

Warning: Recommended UCL exceeds the maximum observation

Note: DL/2 is not a recommended method.

Vanadium (mg/kg)**General Statistics**

Number of Valid Observations	9	Number of Distinct Observations	9
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Raw Statistics

Minimum	22.2	Minimum of Log Data	3.1000923
Maximum	50.2	Maximum of Log Data	3.916015
Mean	31.372667	Mean of log Data	3.4110559
Median	27.9	SD of log Data	0.2720874
SD	9.3388422		
Coefficient of Variation	0.2976745		
Skewness	1.2734694		

Warning: There are only 9 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set, the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics**Normal Distribution Test**

Shapiro Wilk Test Statistic	0.8605131	Shapiro Wilk Test Statistic	0.9135501
Shapiro Wilk Critical Value	0.829	Shapiro Wilk Critical Value	0.829

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	37.161342	95% H-UCL	38.038337
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	43.742497
95% Adjusted-CLT UCL	37.90496	97.5% Chebyshev (MVUE) UCL	49.123216
95% Modified-t UCL	37.381578	99% Chebyshev (MVUE) UCL	59.692596

Assuming Lognormal Distribution**Gamma Distribution Test**

k star (bias corrected)	9.7401369	Data appear Normal at 5% Significance Level	
Theta Star	3.2209677		
nu star	175.32246		
Approximate Chi Square Value (.05)	145.69994	Nonparametric Statistics	
Adjusted Level of Significance	0.02308	95% CLT UCL	36.49301

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit G
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Adjusted Chi Square Value	140.003	95% Jackknife UCL	37.161342
		95% Standard Bootstrap UCL	36.286073
Anderson-Darling Test Statistic	0.4601204	95% Bootstrap-t UCL	41.640303
Anderson-Darling 5% Critical Value	0.7213991	95% Hall's Bootstrap UCL	64.999856
Kolmogorov-Smirnov Test Statistic	0.1922415	95% Percentile Bootstrap UCL	36.466667
Kolmogorov-Smirnov 5% Critical Value	0.2791085	95% BCA Bootstrap UCL	37.433333
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	44.94169
		97.5% Chebyshev(Mean, Sd) UCL	50.813017
		99% Chebyshev(Mean, Sd) UCL	62.346102
Assuming Gamma Distribution			
95% Approximate Gamma UCL	37.751101		
95% Adjusted Gamma UCL	39.287253		
Potential UCL to Use		Use 95% Student's-t UCL	37.161342

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit H

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Summary Statistics for Raw Data Sets with NDs using Detected Data Only

				Raw Statistics using Detected Observations							
Variable	Num Ds	NumNDs	% NDs	Minimum	Maximum	Mean	Median	SD	MAD/0.675	Skewness	CV
Aluminum (mg/kg)	7	0	0.00%	5,395.60	8,960	7,181.50	7,440	1125.319	658.7102	-0.103223	0.156697
Arsenic (mg/kg)	18	1	5.26%	4.035499	23.5	9.3670015	8.3	4.534913	2.887396	1.995704	0.484137
Iron (mg/kg)	7	0	0.00%	12,114	15,913	14,146.14	14,421	1,332.48	1383.247	-0.290213	0.094194
Manganese (mg/kg)	7	0	0.00%	530	656.17	584.62429	570.17	47.41419	59.55523	0.419946	0.081102
Silver (mg/kg)	5	2	28.57%	0.72	82.6	22.226	3.85	35.02479	4.640474	1.881541	1.575848
Thallium (mg/kg)	1	1	50.00%	4.52	4.52	4.52	4.52	N/A	0	N/A	N/A

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit H
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

Full Precision	ON	
Confidence Coefficient	95%	
Number of Bootstrap Operations		2,000

Aluminum (mg/kg)

General Statistics

Number of Valid Observations	7	Number of Distinct Observations	7
------------------------------	---	---------------------------------	---

Raw Statistics

Minimum	5,395.60
Maximum	8,960
Mean	7,181.50
Median	7,440
SD	1,125.32
Coefficient of Variation	0.1566969
Skewness	-0.103223

Log-transformed Statistics

Minimum of Log Data	8.5933391
Maximum of Log Data	9.1005255
Mean of log Data	8.8683658
SD of log Data	0.1611474

Warning: A sample size of 'n' = 7 may not adequate enough to compute meaningful and reliable test statistics and estimates!

It is suggested to collect at least 8 to 10 observations using these statistical methods!

If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Warning: There are only 7 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set, the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.964157
Shapiro Wilk Critical Value	0.803

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.9538796
Shapiro Wilk Critical Value	0.803

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	8,007.99
95% UCLs (Adjusted for Skewness)	
95% Adjusted-CLT UCL	7,863.38
95% Modified-t UCL	8,005.23

Assuming Lognormal Distribution

95% H-UCL	8,174.51
95% Chebyshev (MVUE) UCL	9,091.38
97.5% Chebyshev (MVUE) UCL	9,917.12
99% Chebyshev (MVUE) UCL	11,539.11

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit H
 St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Gamma Distribution Test

k star (bias corrected)

26.407909

Data Distribution**Data appear Normal at 5% Significance Level**

Theta Star

271.94504

nu star

369.71073

Approximate Chi Square Value (.05)

326.14892

Nonparametric Statistics

Adjusted Level of Significance

0.01584

95% CLT UCL

7,881.11

Adjusted Chi Square Value

313.7204

95% Jackknife UCL

8,007.99

95% Standard Bootstrap UCL

7,832.59

Anderson-Darling Test Statistic

0.2846623

95% Bootstrap-t UCL

7,920.98

Anderson-Darling 5% Critical Value

0.7075396

95% Hall's Bootstrap UCL

7,925.00

Kolmogorov-Smirnov Test Statistic

0.185669

95% Percentile Bootstrap UCL

7,806.11

Kolmogorov-Smirnov 5% Critical Value

0.3114079

95% BCA Bootstrap UCL

7,806.66

Data appear Gamma Distributed at 5% Significance Level

95% Chebyshev(Mean, Sd) UCL

9,035.47

97.5% Chebyshev(Mean, Sd) UCL

9,837.69

99% Chebyshev(Mean, Sd) UCL

11,413.49

Assuming Gamma Distribution

95% Approximate Gamma UCL

8,140.69

95% Adjusted Gamma UCL

8,463.20

Potential UCL to Use

Use 95% Student's-t UCL

8,007.99

Arsenic (MG/KG)**General Statistics**

Number of Valid Data

19 Number of Detected Data

18

Number of Distinct Detected Data

18 Number of Non-Detect Data

1

Percent Non-Detects

5.26%

Raw Statistics

Minimum Detected

4.035499

Log-transformed Statistics

Minimum Detected

1.39513

Maximum Detected

23.5

Maximum Detected

3.1570004

Mean of Detected

9.3670015

Mean of Detected

2.1499366

SD of Detected

4.5349127

SD of Detected

0.4130312

Minimum Non-Detect

1.376

Minimum Non-Detect

0.3191807

Maximum Non-Detect

1.376

Maximum Non-Detect

0.3191807

UCL Statistics**Normal Distribution Test with Detected Values Only**

Shapiro Wilk Test Statistic

0.8166109

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic

0.9673556

5% Shapiro Wilk Critical Value

0.897

5% Shapiro Wilk Critical Value

0.897

Data not Normal at 5% Significance Level**Data appear Lognormal at 5% Significance Level**

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit H
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Assuming Normal Distribution

DL/2 Substitution Method

Mean	8.9102119	Mean	2.0170996
SD	4.8360507	SD	0.704546
95% DL/2 (t) UCL	10.834097	95% H-Stat (DL/2) UCL	11.121107

Maximum Likelihood Estimate(MLE) Method

Mean	8.8353491	Mean in Log Scale	2.0968853
SD	4.8653206	SD in Log Scale	0.4632405
95% MLE (t) UCL	10.770878	Mean in Original Scale	9.0388912
95% MLE (Tiku) UCL	10.770479	SD in Original Scale	4.6333983

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean	2.0170996
SD	0.704546
95% H-Stat (DL/2) UCL	11.121107

Log ROS Method

Mean in Log Scale	2.0968853
SD in Log Scale	0.4632405
Mean in Original Scale	9.0388912
SD in Original Scale	4.6333983
95% Percentile Bootstrap UCL	10.797648
95% BCA Bootstrap UCL	11.231823

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	4.9469294
Theta Star	1.8934981
nu star	178.08946

Data Distribution Test with Detected Values Only

Data appear Gamma Distributed at 5% Significance Level

A-D Test Statistic

5% A-D Critical Value

K-S Test Statistic

5% K-S Critical Value

Nonparametric Statistics

0.7423168 Kaplan-Meier (KM) Method

0.7423168 Mean

0.2039758 SD

Data appear Gamma Distributed at 5% Significance Level

SE of Mean

95% KM (t) UCL

95% KM (z) UCL

95% KM (jackknife) UCL

95% KM (bootstrap t) UCL

95% KM (BCA) UCL

95% KM (Percentile Bootstrap) UCL

95% KM (Chebyshev) UCL

97.5% KM (Chebyshev) UCL

99% KM (Chebyshev) UCL

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum

Maximum

Mean

Median

SD

k star

Theta star

Nu star

AppChi2

95% Gamma Approximate UCL

95% Adjusted Gamma UCL

0.8714247

23.5

8.9198659

8.19

4.8188779

2.8200159

3.1630552

107.1606

84.269842

11.342827

11.586655

Potential UCLs to Use

95% KM (BCA) UCL

Note: DL/2 is not a recommended method.

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit H
 St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Iron (mg/kg)**General Statistics**

Number of Valid Observations	7	Number of Distinct Observations	7
------------------------------	---	---------------------------------	---

Raw Statistics

Minimum
 Maximum
 Mean
 Median
 SD
 Coefficient of Variation
 Skewness

Log-transformed Statistics

12,114	Minimum of Log Data	9.4021171
15,913	Maximum of Log Data	9.6748917
14,146.14	Mean of log Data	9.5533172
14,421	SD of log Data	0.095652
1,332.48		
0.0941937		
-0.290213		

Warning: A sample size of 'n' = 7 may not adequate enough to compute meaningful and reliable test statistics and estimates!

It is suggested to collect at least 8 to 10 observations using these statistical methods!

If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Warning: There are only 7 Values In this data

Note: It should be noted that even though bootstrap methods may be performed on this data set, the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics**Normal Distribution Test**

Shapiro Wilk Test Statistic
 Shapiro Wilk Critical Value

Lognormal Distribution Test

0.9754291	Shapiro Wilk Test Statistic	0.969136
0.803	Shapiro Wilk Critical Value	0.803

Data appear Normal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL
95% UCLs (Adjusted for Skewness)
 95% Adjusted-CLT UCL
 95% Modified-t UCL

Assuming Lognormal Distribution

15,124.79	95% H-UCL	N/A
	95% Chebyshev (MVUE) UCL	16,376.58
14,915.51	97.5% Chebyshev (MVUE) UCL	17,341.45
15,115.58	99% Chebyshev (MVUE) UCL	19,236.76

Gamma Distribution Test

k star (bias corrected)
 Theta Star
 nu star
 Approximate Chi Square Value (.05)
 Adjusted Level of Significance
 Adjusted Chi Square Value

Data Distribution

73.826157
 191.61424
 1,033.57

Data appear Normal at 5% Significance Level

Nonparametric Statistics

959.9359	95% CLT UCL	14,974.54
0.01584	95% Jackknife UCL	15,124.79
938.3091	95% Standard Bootstrap UCL	14,915.89
0.1999936	95% Bootstrap-t UCL	15,090.01

Anderson-Darling Test Statistic

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit H
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Anderson-Darling 5% Critical Value	0.70765	95% Hall's Bootstrap UCL	14,874
Kolmogorov-Smirnov Test Statistic	0.1695916	95% Percentile Bootstrap UCL	14,880.14
Kolmogorov-Smirnov 5% Critical Value	0.31132	95% BCA Bootstrap UCL	14,848.57
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	16,341.41
		97.5% Chebyshev(Mean, Sd) UCL	17,291.31
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	19,157.19
95% Approximate Gamma UCL	15,231.20		
95% Adjusted Gamma UCL	15,582.26		
Potential UCL to Use		Use 95% Student's-t UCL	15,124.79

Manganese (mg/kg)

General Statistics

Number of Valid Observations	7	Number of Distinct Observations	7
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Raw Statistics

Minimum	530	Minimum of Log Data	6.272877
Maximum	656.17	Maximum of Log Data	6.4864199
Mean	584.62429	Mean of log Data	6.3681838
Median	570.17	SD of log Data	0.0803808
SD	47.414194		
Coefficient of Variation	0.081102		
Skewness	0.4199457		

Log-transformed Statistics

Warning: A sample size of 'n' = 7 may not adequate enough to compute meaningful and reliable test statistics and estimates!

It is suggested to collect at least 8 to 10 observations using these statistical methods!

If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Warning: There are only 7 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set, the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.9168	Shapiro Wilk Test Statistic	0.9205463
Shapiro Wilk Critical Value	0.803	Shapiro Wilk Critical Value	0.803

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Data appear Lognormal at 5% Significance Level

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit H
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Assuming Normal Distribution

95% Student's-t UCL

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL

95% Modified-t UCL

Assuming Lognormal Distribution

619.44778 95% H-UCL

95% Chebyshev (MVUE) UCL

617.14088 97.5% Chebyshev (MVUE) UCL

619.92186 99% Chebyshev (MVUE) UCL

N/A

662.04665

695.5518

761.36618

Gamma Distribution Test

k star (bias corrected)

Theta Star

nu star

Approximate Chi Square Value (.05)

Adjusted Level of Significance

Adjusted Chi Square Value

Anderson-Darling Test Statistic

Anderson-Darling 5% Critical Value

Kolmogorov-Smirnov Test Statistic

Kolmogorov-Smirnov 5% Critical Value

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL

95% Adjusted Gamma UCL

102.75955

5.6892454

1,438.63

1,351.56

0.01584

1325.8126

0.3803227

0.70765

0.2137653

0.31132

Data Distribution

Data appear Normal at 5% Significance Level

Nonparametric Statistics

95% CLT UCL

95% Jackknife UCL

95% Standard Bootstrap UCL

95% Bootstrap-t UCL

95% Hall's Bootstrap UCL

95% Percentile Bootstrap UCL

95% BCA Bootstrap UCL

95% Chebyshev(Mean, Sd) UCL

97.5% Chebyshev(Mean, Sd) UCL

99% Chebyshev(Mean, Sd) UCL

614.10151

619.44778

611.91863

624.48744

609.0149

612.93429

614.17143

662.73959

696.54015

762.9348

Potential UCL to Use

Use 95% Student's-t UCL

619.44778

Silver (mg/kg)

General Statistics

Number of Valid Data

Number of Distinct Detected Data

7 Number of Detected Data

5 Number of Non-Detect Data

Percent Non-Detects

5

2

28.57%

Raw Statistics

Minimum Detected

Maximum Detected

Mean of Detected

SD of Detected

Minimum Non-Detect

Maximum Non-Detect

Log-transformed Statistics

0.72 Minimum Detected

82.6 Maximum Detected

22.226 Mean of Detected

35.024788 SD of Detected

2.5 Minimum Non-Detect

2.5 Maximum Non-Detect

-0.328504

4.4140097

1.6606588

2.0964713

0.9162907

0.9162907

Warning: There are only 5 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit H
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic 0.729557
5% Shapiro Wilk Critical Value 0.762

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic 0.8995501
5% Shapiro Wilk Critical Value 0.762

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean 16.232857
SD 30.374068
95% DL/2 (t) UCL 38.541178

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean 1.2499402
SD 1.8499027
95% H-Stat (DL/2) UCL 1836.6374

Maximum Likelihood Estimate(MLE) Method

N/A

Log ROS Method

MLE yields a negative mean

Mean in Log Scale 1.0901281
SD in Log Scale 2.0073571
Mean in Original Scale 16.127519
SD in Original Scale 30.436618
95% Percentile Bootstrap UCL 36.548843
95% BCA Bootstrap UCL 42.336757

Gamma Distribution Test with Detected Values Only

k star (bias corrected) 0.3127321
Theta Star 71.070417
nu star 3.1273209

Data Distribution Test with Detected Values Only

Data appear Gamma Distributed at 5% Significance Level

A-D Test Statistic

0.3859623

5% A-D Critical Value

0.7182219

K-S Test Statistic

0.7182219

5% K-S Critical Value

0.3737548

Data appear Gamma Distributed at 5% Significance Level

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean 16.087143

SD 28.199395

SE of Mean 11.916421

95% KM (t) UCL 39.242889

95% KM (z) UCL 35.687912

95% KM (jackknife) UCL 38.457727

95% KM (bootstrap t) UCL 306.78715

95% KM (BCA) UCL 39.022857

95% KM (Percentile Bootstrap) UCL 37.158571

95% KM (Chebyshev) UCL 68.029619

97.5% KM (Chebyshev) UCL 90.50517

99% KM (Chebyshev) UCL 134.65404

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum 0.72

Maximum 82.6

Mean 17.934256

Median 3.85

SD 29.710428

k star 0.3782629

Theta star 47.412149

Nu star 5.2956803

AppChi2 1.2911928

95% Gamma Approximate UCL 73.555306

95% Adjusted Gamma UCL 120.1886

Potential UCLs to Use

95% KM (Chebyshev) UCL 68.029619

Note: DL/2 is not a recommended method.

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit H
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Thallium (mg/kg)

General Statistics

Number of Valid Data	2	Number of Detected Data	1
Number of Distinct Detected Data	1	Number of Non-Detect Data	1
		Percent Non-Detects	50.00%

Warning: This data set only has 2 observations!

Data set is too small to compute reliable and meaningful statistics and estimates!

The data set for variable Thallium (mg/kg) was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!

If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit I

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Summary Statistics for Raw Data Sets with NDs using Detected Data Only

				Raw Statistics using Detected Observations							
Variable	Num Ds	NumNDs	% NDs	Minimum	Maximum	Mean	Median	SD	MAD/0.675	Skewness	CV
Aluminum (mg/kg)	8	0	0.00%	7,161.80	9,440	8,180.09	7,925.50	946.2983	1,121.05	0.399091	0.115683
Iron (mg/kg)	8	0	0.00%	13,876	17,800	15,669.25	15,503.50	1,278.97	1,540.40	0.304568	0.081623
Manganese (mg/kg)	8	0	0.00%	562	1,120	789.63875	722.5	196.7654	133.2913	0.858824	0.249184
Thallium (mg/kg)	1	3	75.00%	5.78	5.78	5.78	5.78	N/A	0	N/A	N/A

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit I
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

Full Precision	ON	
Confidence Coefficient	95%	
Number of Bootstrap Operations		2,000

Aluminum (mg/kg)

General Statistics

Number of Valid Observations	8	Number of Distinct Observations	8
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Raw Statistics

Minimum	7,161.80
Maximum	9,440
Mean	8,180.09
Median	7925.5
SD	946.29826
Coefficient of Variation	0.1156831
Skewness	0.3990908

Log-transformed Statistics

Minimum of Log Data	8.8765166
Maximum of Log Data	9.1527113
Mean of log Data	9.003689
SD of log Data	0.1143999

Warning: There are only 8 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set, the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.8757365
Shapiro Wilk Critical Value	0.818

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.8831026
Shapiro Wilk Critical Value	0.818

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	8,813.95
95% UCLs (Adjusted for Skewness)	
95% Adjusted-CLT UCL	8,780.84
95% Modified-t UCL	8,821.82

Assuming Lognormal Distribution

95% H-UCL	8,872.49
95% Chebyshev (MVUE) UCL	9,622.71
97.5% Chebyshev (MVUE) UCL	10,247.10
99% Chebyshev (MVUE) UCL	11,473.59

Gamma Distribution Test

k star (bias corrected)	54.354845
Theta Star	150.49417
nu star	869.67753

Data Distribution

Data appear Normal at 5% Significance Level

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit I
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Approximate Chi Square Value (.05)	802.23366	Nonparametric Statistics	
Adjusted Level of Significance	0.01946	95% CLT UCL	8,730.40
Adjusted Chi Square Value	785.74508	95% Jackknife UCL	8,813.95
		95% Standard Bootstrap UCL	8,702.94
Anderson-Darling Test Statistic	0.4530442	95% Bootstrap-t UCL	8,858.74
Anderson-Darling 5% Critical Value	0.7147353	95% Hall's Bootstrap UCL	8,680.60
Kolmogorov-Smirnov Test Statistic	0.1757259	95% Percentile Bootstrap UCL	8,699.73
Kolmogorov-Smirnov 5% Critical Value	0.2935352	95% BCA Bootstrap UCL	8,727.24
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	9,638.43
		97.5% Chebyshev(Mean, Sd) UCL	10,269.46
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	11,508.99
95% Approximate Gamma UCL	8,867.79		
95% Adjusted Gamma UCL	9,053.88		

Potential UCL to Use	Use 95% Student's-t UCL	8,813.95
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Iron (mg/kg)

General Statistics

Number of Valid Observations	8	Number of Distinct Observations	8
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Raw Statistics

		Log-transformed Statistics	
Minimum	13,876	Minimum of Log Data	9.537916
Maximum	17,800	Maximum of Log Data	9.7869537
Mean	15,669.25	Mean of log Data	9.6565593
Median	15,503.50	SD of log Data	0.0812557
SD	1,278.97		
Coefficient of Variation	0.0816227		
Skewness	0.3045676		

Warning: There are only 8 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set, the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.9780591	Shapiro Wilk Test Statistic	0.9821673
Shapiro Wilk Critical Value	0.818	Shapiro Wilk Critical Value	0.818
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Lognormal Distribution Test

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit I
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Assuming Normal Distribution

95% Student's-t UCL
95% UCLs (Adjusted for Skewness)
95% Adjusted-CLT UCL
95% Modified-t UCL

16,525.95
16,465.05
16,534.06

Assuming Lognormal Distribution

95% H-UCL
95% Chebyshev (MVUE) UCL
97.5% Chebyshev (MVUE) UCL
99% Chebyshev (MVUE) UCL

N/A
17,631.88
18,481.18
20,149.44

Gamma Distribution Test

k star (bias corrected)
Theta Star
nu star
Approximate Chi Square Value (.05)
Adjusted Level of Significance
Adjusted Chi Square Value

108.08665
144.96933
1,729.39

Data Distribution

Data appear Normal at 5% Significance Level

Anderson-Darling Test Statistic
Anderson-Darling 5% Critical Value
Kolmogorov-Smirnov Test Statistic
Kolmogorov-Smirnov 5% Critical Value

0.171696
0.71473
0.1484879
0.29358

Nonparametric Statistics

95% CLT UCL
95% Jackknife UCL
95% Standard Bootstrap UCL
95% Bootstrap-t UCL
95% Hall's Bootstrap UCL
95% Percentile Bootstrap UCL
95% BCA Bootstrap UCL
95% Chebyshev(Mean, Sd) UCL
97.5% Chebyshev(Mean, Sd) UCL
99% Chebyshev(Mean, Sd) UCL

16,413.03
16,525.95
16,352.85
16,644.07
16,567.07
16,396
16,410.25
17,640.27
18,493.13
20,168.41

Assuming Gamma Distribution

95% Approximate Gamma UCL
95% Adjusted Gamma UCL

16,585.98
16,829.86

Potential UCL to Use

Use 95% Student's-t UCL

16,525.95

Manganese (mg/kg)

General Statistics

Number of Valid Observations

8 Number of Distinct Observations

8

Raw Statistics

Minimum
Maximum
Mean
Median
SD
Coefficient of Variation
Skewness

562
1,120
789.63875
722.5
196.76544
0.2491841
0.858824

Log-transformed Statistics

Minimum of Log Data
Maximum of Log Data
Mean of log Data
SD of log Data

6.3315018
7.021084
6.6459972
0.2383774

Warning: There are only 8 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set, the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit I
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic
Shapiro Wilk Critical Value

0.8976706
0.818

Lognormal Distribution Test

Shapiro Wilk Test Statistic
Shapiro Wilk Critical Value

0.933346
0.818

Data appear Normal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL

921.43907

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL

926.63704

95% Modified-t UCL

924.95963

Assuming Lognormal Distribution

95% H-UCL

946.92755

95% Chebyshev (MVUE) UCL

1,079.64

97.5% Chebyshev (MVUE) UCL

1,205.39

99% Chebyshev (MVUE) UCL

1,452.41

Gamma Distribution Test

k star (bias corrected)

12.403971

Theta Star

63.660158

nu star

198.46354

Approximate Chi Square Value (.05)

166.86885

Adjusted Level of Significance

0.01946

Adjusted Chi Square Value

159.5278

Data Distribution

Data appear Normal at 5% Significance Level

Nonparametric Statistics

95% CLT UCL

904.06643

95% Jackknife UCL

921.43907

95% Standard Bootstrap UCL

896.31616

95% Bootstrap-t UCL

1003.3773

95% Hall's Bootstrap UCL

1044.9184

95% Percentile Bootstrap UCL

904.5375

95% BCA Bootstrap UCL

919.10125

Anderson-Darling Test Statistic

0.3803

Anderson-Darling 5% Critical Value

0.7162036

Kolmogorov-Smirnov Test Statistic

0.2119504

Kolmogorov-Smirnov 5% Critical Value

0.2938721

Data appear Gamma Distributed at 5% Significance Level

95% Chebyshev(Mean, Sd) UCL

1,092.87

97.5% Chebyshev(Mean, Sd) UCL

1,224.09

99% Chebyshev(Mean, Sd) UCL

1,481.82

Assuming Gamma Distribution

95% Approximate Gamma UCL

939.14773

95% Adjusted Gamma UCL

982.3648

Potential UCL to Use

Use 95% Student's-t UCL

921.43907

Thallium (mg/kg)

General Statistics

Number of Valid Data

4 Number of Detected Data

1

Number of Distinct Detected Data

1 Number of Non-Detect Data

3

Percent Non-Detects

75.00%

Warning: This data set only has 4 observations!

Data set is too small to compute reliable and meaningful statistics and estimates!

The data set for variable Thallium (mg/kg) was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!

If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit J

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Summary Statistics for Raw Data Sets with NDs using Detected Data Only

				Raw Statistics using Detected Observations							
Variable	Num Ds	NumNDs	% NDs	Minimum	Maximum	Mean	Median	SD	MAD/0.675	Skewness	CV
Aluminum (mg/kg)	8	0	0.00%	4,192.70	9,733.40	7,377.23	7,542.30	1,570.21	777.68718	-0.923832	0.2128455
Arsenic (mg/kg)	22	0	0.00%	5.729168	36.3	10.27105	8.18	6.743424	2.7427724	3.0474051	0.6565467
Benzo(b)fluoranthene (mg/kg)	10	0	0.00%	0.0172	0.7669	0.3261	0.32145	0.240071	0.2628614	0.5466378	0.7361888
Copper (mg/kg)	8	0	0.00%	11.975	410.2	77.38325	19.7545	136.0501	8.1186064	2.7035772	1.7581336
Iron (mg/kg)	8	0	0.00%	9,094.20	18,123	15,353.03	15,880.50	2,847.30	1,890.29	-1.716439	0.1854554
Manganese (mg/kg)	8	0	0.00%	336.26	938.2	622.63	594.39	199.9374	263.15789	0.1137941	0.3211175
Thallium (mg/kg)	4	0	0.00%	.02	8.64	2.36	0.3	4.186932	0.074129	1.9992374	1.7741238

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit J
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

Full Precision	ON	
Confidence Coefficient	95%	
Number of Bootstrap Operations		2,000

Aluminum (mg/kg)

General Statistics

Number of Valid Observations	8	Number of Distinct Observations	8
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Raw Statistics

Minimum	4,192.70
Maximum	9,733.40
Mean	7,377.23
Median	7,542.30
SD	1,570.21
Coefficient of Variation	0.2128455
Skewness	-0.923832

Log-transformed Statistics

Minimum of Log Data	8.3411002
Maximum of Log Data	9.1833185
Mean of log Data	8.8824424
SD of log Data	0.2448033

Warning: There are only 8 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set, the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.9133559
Shapiro Wilk Critical Value	0.818

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.8369002
Shapiro Wilk Critical Value	0.818

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	8,429.01
95% UCLs (Adjusted for Skewness)	
95% Adjusted-CLT UCL	8,096.62
95% Modified-t UCL	8,398.78

Assuming Lognormal Distribution

95% H-UCL	8,925.91
95% Chebyshev (MVUE) UCL	10,192.92
97.5% Chebyshev (MVUE) UCL	11,403.49
99% Chebyshev (MVUE) UCL	13,781.44

Gamma Distribution Test

k star (bias corrected)	13.366508
Theta Star	551.91866
nu star	213.86412

Data Distribution

Data appear Normal at 5% Significance Level

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit J

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Approximate Chi Square Value (.05)	181.02031	Nonparametric Statistics.	
Adjusted Level of Significance	0.01946	95% CLT UCL	8,290.37
Adjusted Chi Square Value	173.36091	95% Jackknife UCL	8,429.01
		95% Standard Bootstrap UCL	8,246.82
Anderson-Darling Test Statistic	0.5729935	95% Bootstrap-t UCL	8,208.56
Anderson-Darling 5% Critical Value	0.7161778	95% Hall's Bootstrap UCL	8,254.11
Kolmogorov-Smirnov Test Statistic	0.2392237	95% Percentile Bootstrap UCL	8,194.83
Kolmogorov-Smirnov 5% Critical Value	0.2938412	95% BCA Bootstrap UCL	8,069.81
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	9,797.08
		97.5% Chebyshev(Mean, Sd) UCL	10,844.15
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	12,900.93
95% Approximate Gamma UCL	8,715.73		
95% Adjusted Gamma UCL	9,100.80		

Potential UCL to Use	Use 95% Student's-t UCL	8,429.01
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Arsenic (MG/KG)**General Statistics**

Number of Valid Observations	22	Number of Distinct Observations	22
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Raw Statistics

		Log-transformed Statistics	
Minimum	5.729168	Minimum of Log Data	1.7455703
Maximum	36.3	Maximum of Log Data	3.5918177
Mean	10.27105	Mean of log Data	2.2072562
Median	8.18	SD of log Data	0.4526559
SD	6.7434241		
Coefficient of Variation	0.6565467		
Skewness	3.0474051		

Relevant UCL Statistics**Normal Distribution Test**

Shapiro Wilk Test Statistic	0.6349744	Shapiro Wilk Test Statistic	0.8541718
Shapiro Wilk Critical Value	0.911	Shapiro Wilk Critical Value	0.911

Data not Normal at 5% Significance Level**Lognormal Distribution Test****Data not Lognormal at 5% Significance Level****Assuming Normal Distribution**

95% Student's-t UCL	12.744967	95% H-UCL	12.199361
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	14.370944
95% Adjusted-CLT UCL	13.633948	97.5% Chebyshev (MVUE) UCL	16.253369
95% Modified-t UCL	12.900648	99% Chebyshev (MVUE) UCL	19.951028

Assuming Lognormal Distribution

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit J
 St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Gamma Distribution Test

k star (bias corrected)	3.705474	Data Distribution	
Theta Star	2.7718587	Data do not follow a Discernable Distribution (0.05)	
nu star	163.04086		
Approximate Chi Square Value (.05)	134.51823	Nonparametric Statistics	
Adjusted Level of Significance	0.0386	95% CLT UCL	12.635861
Adjusted Chi Square Value	132.58609	95% Jackknife UCL	12.744967
		95% Standard Bootstrap UCL	12.535372

Anderson-Darling Test Statistic	1.4043304	95% Bootstrap-t UCL	15.359732
Anderson-Darling 5% Critical Value	0.7465617	95% Hall's Bootstrap UCL	21.985722
Kolmogorov-Smirnov Test Statistic	0.1932507	95% Percentile Bootstrap UCL	12.713444
Kolmogorov-Smirnov 5% Critical Value	0.1861087	95% BCA Bootstrap UCL	13.967342
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	16.537852
		97.5% Chebyshev(Mean, Sd) UCL	19.249502
		99% Chebyshev(Mean, Sd) UCL	24.576013

Assuming Gamma Distribution

95% Approximate Gamma UCL	12.448877
95% Adjusted Gamma UCL	12.63029

Potential UCL to Use

Use 95% Student's-t UCL	12.744967
or 95% Modified-t UCL	12.900648

Benzo(b)fluoranthene (mg/kg)**General Statistics**

Number of Valid Observations	10	Number of Distinct Observations	10
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Raw Statistics

Minimum	0.0172	Log-transformed Statistics	
Maximum	0.7669	Minimum of Log Data	-4.062846
Mean	0.3261	Maximum of Log Data	-0.265399
Median	0.32145	Mean of log Data	-1.514664
SD	0.2400712	SD of log Data	1.1292899
Coefficient of Variation	0.7361888		
Skewness	0.5466378		

Relevant UCL Statistics**Normal Distribution Test**

Shapiro Wilk Test Statistic	0.9531184	Lognormal Distribution Test	
Shapiro Wilk Critical Value	0.842	Shapiro Wilk Test Statistic	0.8936663
		Shapiro Wilk Critical Value	0.842

Data appear Normal at 5% Significance Level**Data appear Lognormal at 5% Significance Level****Assuming Normal Distribution**

95% Student's-t UCL	0.4652647	Assuming Lognormal Distribution	
95% UCLs (Adjusted for Skewness)		95% H-UCL	1.4816296
95% Adjusted-CLT UCL	0.464995	95% Chebyshev (MVUE) UCL	1.0032219
95% Modified-t UCL	0.4674519	97.5% Chebyshev (MVUE) UCL	1.2729008
		99% Chebyshev (MVUE) UCL	1.8026328

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit J
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Gamma Distribution Test

k star (bias corrected)
Theta Star
nu star
Approximate Chi Square Value (.05)
Adjusted Level of Significance
Adjusted Chi Square Value

1.0551714 Data appear Normal at 5% Significance Level

0.3090493

21.103427

11.668548 Nonparametric Statistics

0.0267

10.468843

95% CLT UCL 0.4509726
95% Jackknife UCL 0.4652647
95% Standard Bootstrap UCL 0.4467394
95% Bootstrap-t UCL 0.4839677
95% Hall's Bootstrap UCL 0.4813428
95% Percentile Bootstrap UCL 0.44164
95% BCA Bootstrap UCL 0.45076
95% Chebyshev(Mean, Sd) UCL 0.6570153
97.5% Chebyshev(Mean, Sd) UCL 0.8002026
99% Chebyshev(Mean, Sd) UCL 1.0814663

Anderson-Darling Test Statistic

0.2330696

Anderson-Darling 5% Critical Value

0.7408183

Kolmogorov-Smirnov Test Statistic

0.1886993

Kolmogorov-Smirnov 5% Critical Value

0.2715821

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL

0.5897758

95% Adjusted Gamma UCL

0.6573628

Potential UCL to Use

Use 95% Student's-t UCL

0.4652647

Copper (mg/kg)

General Statistics

Number of Valid Observations

8 Number of Distinct Observations

8

Raw Statistics

Minimum

11.975 Minimum of Log Data

2.4828211

Maximum

410.2 Maximum of Log Data

6.0166448

Mean

77.38325 Mean of log Data

3.5400277

Median

19.7545 SD of log Data

1.1771299

SD

136.05009

Coefficient of Variation

1.7581336

Skewness

2.7035772

Log-transformed Statistics

Warning: There are only 8 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set, the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit J
 St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Relevant UCL Statistics**Normal Distribution Test**

Shapiro Wilk Test Statistic
 Shapiro Wilk Critical Value

0.5378569 Shapiro Wilk Test Statistic
 0.818 Shapiro Wilk Critical Value

Lognormal Distribution Test

0.8127111
 0.818

Data not Normal at 5% Significance Level**Data not Lognormal at 5% Significance Level****Assuming Normal Distribution**

95% Student's-t UCL

168.51432

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL

205.63019

95% Modified-t UCL

176.17728

Assuming Lognormal Distribution

95% H-UCL

386.47493

95% Chebyshev (MVUE) UCL

173.7678

97.5% Chebyshev (MVUE) UCL

222.57247

99% Chebyshev (MVUE) UCL

318.43979

Gamma Distribution Test

k star (bias corrected)

0.546689

Theta Star

141.54895

nu star

8.7470234

Approximate Chi Square Value (.05)

3.174888

Adjusted Level of Significance

0.01946

Adjusted Chi Square Value

2.3879848

Data Distribution**Data Follow Appr. Gamma Distribution at 5% Significance Level****Nonparametric Statistics**

95% CLT UCL

156.50231

95% Jackknife UCL

168.51432

95% Standard Bootstrap UCL

150.76108

95% Bootstrap-t UCL

556.21963

95% Hall's Bootstrap UCL

533.06981

95% Percentile Bootstrap UCL

169.58075

95% BCA Bootstrap UCL

218.223

Anderson-Darling Test Statistic

1.0789309

Anderson-Darling 5% Critical Value

0.7457252

Kolmogorov-Smimov Test Statistic

0.3026745

Kolmogorov-Smimov 5% Critical Value

0.3042302

Data follow Appr. Gamma Distribution at 5% Significance Level

95% Chebyshev(Mean, Sd) UCL

287.05052

97.5% Chebyshev(Mean, Sd) UCL

377.77372

99% Chebyshev(Mean, Sd) UCL

555.98188

Assuming Gamma Distribution

95% Approximate Gamma UCL

213.1959

95% Adjusted Gamma UCL

283.44951

Potential UCL to Use

Use 95% Approximate Gamma UCL

213.1959

Iron (mg/kg)**General Statistics**

Number of Valid Observations

8 Number of Distinct Observations

8

Raw Statistics

Minimum

9,094.20

Maximum

18,123

Mean

15,353.03

Median

15,880.50

SD

2,847.30

Coefficient of Variation

0.1854554

Skewness

-1.716439

Log-transformed Statistics

Minimum of Log Data

9.1153921

Maximum of Log Data

9.8049371

Mean of log Data

9.620283

SD of log Data

0.2194684

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit J
 St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Warning: There are only 8 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set, the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics**Normal Distribution Test**

Shapiro Wilk Test Statistic
 Shapiro Wilk Critical Value

0.8371079 Shapiro Wilk Test Statistic
 0.818 Shapiro Wilk Critical Value

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

0.762533 Shapiro Wilk Test Statistic
 0.818 Shapiro Wilk Critical Value

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL
95% UCLs (Adjusted for Skewness)
 95% Adjusted-CLT UCL
 95% Modified-t UCL

17,260.25
 16,356.10
 17,158.43

Assuming Lognormal Distribution

95% H-UCL
 95% Chebyshev (MVUE) UCL
 97.5% Chebyshev (MVUE) UCL
 99% Chebyshev (MVUE) UCL

18,165.17
 20,603.57
 22,860.60
 27,294.09

Gamma Distribution Test

k star (bias corrected)
 Theta Star
 nu star
 Approximate Chi Square Value (.05)
 Adjusted Level of Significance
 Adjusted Chi Square Value

16.822613
 912.64208
 269.16182
 232.16863

Data Distribution

Data appear Normal at 5% Significance Level

Anderson-Darling Test Statistic
 Anderson-Darling 5% Critical Value
 Kolmogorov-Smirnov Test Statistic
 Kolmogorov-Smirnov 5% Critical Value

0.7488891
 0.7159031
 0.2519807
 0.2937583

Nonparametric Statistics

95% CLT UCL
 95% Jackknife UCL
 95% Standard Bootstrap UCL
 95% Bootstrap-t UCL
 95% Hall's Bootstrap UCL
 95% Percentile Bootstrap UCL
 95% BCA Bootstrap UCL
 95% Chebyshev(Mean, Sd) UCL
 97.5% Chebyshev(Mean, Sd) UCL
 99% Chebyshev(Mean, Sd) UCL

17,008.86
 17,260.25
 16,907.36
 16,827.49
 16,562.02
 16,776.13
 16,555.50
 19,741.01
 21,639.70
 25,369.30

Data follow Appr. Gamma Distribution at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL
 95% Adjusted Gamma UCL

17,799.34
 18,493.73

Potential UCL to Use

Use 95% Student's-t UCL 17,260.25

Manganese (mg/kg)**General Statistics**

Number of Valid Observations

8 Number of Distinct Observations

8

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit J
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Raw Statistics

Minimum	336.26
Maximum	938.2
Mean	622.63
Median	594.39
SD	199.9374
Coefficient of Variation	0.3211175
Skewness	0.1137941

Log-transformed Statistics

Minimum of Log Data	5.8178847
Maximum of Log Data	6.8439631
Mean of log Data	6.3851275
SD of log Data	0.3422601

Warning: There are only 8 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set, the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.9649498
Shapiro Wilk Critical Value	0.818

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.9511276
Shapiro Wilk Critical Value	0.818

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	756.55501
95% UCLs (Adjusted for Skewness)	
95% Adjusted-CLT UCL	741.94112
95% Modified-t UCL	757.029

Assuming Lognormal Distribution

95% H-UCL	826.39111
95% Chebyshev (MVUE) UCL	954.78765
97.5% Chebyshev (MVUE) UCL	1,097.94
99% Chebyshev (MVUE) UCL	1,379.12

Gamma Distribution Test

k star (bias corrected)	6.5861823
Theta Star	94.535798
nu star	105.37892
Approximate Chi Square Value (.05)	82.689606
Adjusted Level of Significance	0.01946
Adjusted Chi Square Value	77.615857

Data Distribution

Data appear Normal at 5% Significance Level

Anderson-Darling Test Statistic	0.2543094
Anderson-Darling 5% Critical Value	0.7150214
Kolmogorov-Smirnov Test Statistic	0.1627428
Kolmogorov-Smirnov 5% Critical Value	0.294263

Data appear Gamma Distributed at 5% Significance Level

Nonparametric Statistics

95% CLT UCL	738.90231
95% Jackknife UCL	756.55501
95% Standard Bootstrap UCL	733.11956
95% Bootstrap-t UCL	755.90733
95% Hall's Bootstrap UCL	753.56734
95% Percentile Bootstrap UCL	733.41375
95% BCA Bootstrap UCL	728.78125
95% Chebyshev(Mean, Sd) UCL	930.75423
97.5% Chebyshev(Mean, Sd) UCL	1064.0798
99% Chebyshev(Mean, Sd) UCL	1,325.97

Assuming Gamma Distribution

95% Approximate Gamma UCL	793.47427
95% Adjusted Gamma UCL	845.34369

APPENDIX R
ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit J
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Potential UCL to Use	Use 95% Student's-t UCL	756.55501
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Thallium (mg/kg)

General Statistics		
Number of Valid Observations	4 Number of Distinct Observations	3

Warning: This data set only has 4 observations!
Data set is too small to compute reliable and meaningful statistics and estimates!
The data set for variable Thallium (mg/kg) was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit K

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Summary Statistics for Raw Data Sets with NDs using Detected Data Only

				Raw Statistics using Detected Observations							
Variable	Num Ds	NumNDs	% NDs	Minimum	Maximum	Mean	Median	SD	MAD/0.675	Skewness	CV
Aluminum (mg/kg)	12	0	0.00%	5,136.10	10,700	8,545.80	8,974.50	1,662.25	1,609.86	-0.744084	0.1945106
Iron (mg/kg)	12	0	0.00%	4,600	17,500	14,698	15,758.50	3,437.84	1,462.56	-2.639161	0.2338982
Manganese (mg/kg)	12	0	0.00%	539.37	1,050	748.35	669.845	180.91	126.06375	0.6062116	0.2417452
Thallium (mg/kg)	1	4	80.00%	7.67	7.67	7.67	7.67	N/A	0	N/A	N/A
Vanadium (mg/kg)	9	0	0.00%	18.389	48.7	27.405889	25.438	8.386432	1.3906597	2.4121549	0.3060084

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit K
 St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

General UCL Statistics for Data Sets with Non-Detects**User Selected Options**

Full Precision	ON	
Confidence Coefficient	95%	
Number of Bootstrap Operations		2,000

Aluminum (mg/kg)**General Statistics**

Number of Valid Observations	12	Number of Distinct Observations	12
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Raw Statistics

Minimum	5,136.10
Maximum	10,700
Mean	8,545.80
Median	8,974.50
SD	1,662.25
Coefficient of Variation	0.1945106
Skewness	-0.744084

Log-transformed Statistics

Minimum of Log Data	8.5440493
Maximum of Log Data	9.277999
Mean of log Data	9.0334547
SD of log Data	0.2149061

Relevant UCL Statistics**Normal Distribution Test**

Shapiro Wilk Test Statistic	0.9309049
Shapiro Wilk Critical Value	0.859

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.8909519
Shapiro Wilk Critical Value	0.859

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	9,407.55
95% UCLs (Adjusted for Skewness)	
95% Adjusted-CLT UCL	9,224.95
95% Modified-t UCL	9,390.38

Assuming Lognormal Distribution

95% H-UCL	9,669.31
95% Chebyshev (MVUE) UCL	10,882.94
97.5% Chebyshev (MVUE) UCL	11,889.07
99% Chebyshev (MVUE) UCL	13,865.42

Gamma Distribution Test

k star (bias corrected)	19.17616
Theta Star	445.6471
nu star	460.22783
Approximate Chi Square Value (.05)	411.48722
Adjusted Level of Significance	0.02896
Adjusted Chi Square Value	404.44963

Data Distribution

Data appear Normal at 5% Significance Level

Anderson-Darling Test Statistic	0.5251074
Anderson-Darling 5% Critical Value	0.7314516
Kolmogorov-Smirnov Test Statistic	0.2534479
Kolmogorov-Smirnov 5% Critical Value	0.2451542

Nonparametric Statistics

95% CLT UCL	9,335.08
95% Jackknife UCL	9,407.55
95% Standard Bootstrap UCL	9,298.70
95% Bootstrap-t UCL	9,291.84
95% Hall's Bootstrap UCL	9,238.35
95% Percentile Bootstrap UCL	9,293.43
95% BCA Bootstrap UCL	9,187.71

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit K
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Data follow Appr. Gamma Distribution at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	10,637.42
		97.5% Chebyshev(Mean, Sd) UCL	11,542.46
		99% Chebyshev(Mean, Sd) UCL	13,320.25
Assuming Gamma Distribution			
95% Approximate Gamma UCL	9,558.05		
95% Adjusted Gamma UCL	9,724.36		

Potential UCL to Use	Use 95% Student's-t UCL	9,407.55
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Iron (mg/kg)**General Statistics**

Number of Valid Observations	12	Number of Distinct Observations	12
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Raw Statistics

Minimum	4,600	Minimum of Log Data	8.4338116
Maximum	17,500	Maximum of Log Data	9.7699562
Mean	14,698	Mean of log Data	9.5508674
Median	15,758.50	SD of log Data	0.3621593
SD	3,437.84		
Coefficient of Variation	0.2338982		
Skewness	-2.639161		

Log-transformed Statistics**Relevant UCL Statistics****Normal Distribution Test**

Shapiro Wilk Test Statistic	0.6799883	Shapiro Wilk Test Statistic	0.5449618
Shapiro Wilk Critical Value	0.859	Shapiro Wilk Critical Value	0.859

Data not Normal at 5% Significance Level**Lognormal Distribution Test****Data not Lognormal at 5% Significance Level****Assuming Normal Distribution**

95% Student's-t UCL	16,480.27	95% H-UCL	18,646.11
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	21,813.59
95% Adjusted-CLT UCL	15,522.50	97.5% Chebyshev (MVUE) UCL	24,794.84
95% Modified-t UCL	16,354.25	99% Chebyshev (MVUE) UCL	30,650.93

Assuming Lognormal Distribution**Gamma Distribution Test**

k star (bias corrected)	8.5868517	Data do not follow a Discernable Distribution (0.05)	
Theta Star	1711.6867		
nu star	206.08444		
Approximate Chi Square Value (.05)	173.86578	Nonparametric Statistics	
Adjusted Level of Significance	0.02896	95% CLT UCL	16,330.38
Adjusted Chi Square Value	169.35057	95% Jackknife UCL	16,480.27
		95% Standard Bootstrap UCL	16,242.92
Anderson-Darling Test Statistic	1.9757316	95% Bootstrap-t UCL	15,963.39
Anderson-Darling 5% Critical Value	0.7305145	95% Hall's Bootstrap UCL	15,772.10

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit K
 St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Kolmogorov-Smirnov Test Statistic	0.3112638	95% Percentile Bootstrap UCL	16,040.42
Kolmogorov-Smirnov 5% Critical Value	0.2453552	95% BCA Bootstrap UCL	15,828.33
Data not Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	19,023.85
		97.5% Chebyshev(Mean, Sd) UCL	20,895.65
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	24,572.43
95% Approximate Gamma UCL	17,421.65		
95% Adjusted Gamma UCL	17,886.15		

Potential UCL to Use	Use 95% Student's-t UCL	16,480.27
	or 95% Modified-t UCL	16,354.25

Manganese (mg/kg)**General Statistics**

Number of Valid Observations	12	Number of Distinct Observations	12
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Raw Statistics

Minimum	539.37	Minimum of Log Data	6.2904018
Maximum	1,050	Maximum of Log Data	6.9565454
Mean	748.35	Mean of log Data	6.592207
Median	669.845	SD of log Data	0.2340347
SD	180.91001		
Coefficient of Variation	0.2417452		
Skewness	0.6062116		

Log-transformed Statistics**Relevant UCL Statistics****Normal Distribution Test**

Shapiro Wilk Test Statistic	0.8683104	Shapiro Wilk Test Statistic	0.8920443
Shapiro Wilk Critical Value	0.859	Shapiro Wilk Critical Value	0.859

Data appear Normal at 5% Significance Level**Lognormal Distribution Test****Data appear Lognormal at 5% Significance Level****Assuming Normal Distribution**

95% Student's-t UCL	842.13868	95% H-UCL	855.36937
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	969.38578
95% Adjusted-CLT UCL	844.01651	97.5% Chebyshev (MVUE) UCL	1,065.23
95% Modified-t UCL	843.66187	99% Chebyshev (MVUE) UCL	1,253.48

Assuming Lognormal Distribution**Gamma Distribution Test**

k star (bias corrected)	14.791485	Data appear Normal at 5% Significance Level	
Theta Star	50.593299		
nu star	354.99563		
Approximate Chi Square Value (.05)	312.33354	Nonparametric Statistics	
Adjusted Level of Significance	0.02896	95% CLT UCL	834.2512
Adjusted Chi Square Value	306.22425	95% Jackknife UCL	842.13868

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit K
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

		95% Standard Bootstrap UCL	829.49924
Anderson-Darling Test Statistic	0.6800817	95% Bootstrap-t UCL	863.41358
Anderson-Darling 5% Critical Value	0.7318051	95% Hall's Bootstrap UCL	826.21561
Kolmogorov-Smirnov Test Statistic	0.234424	95% Percentile Bootstrap UCL	834.11583
Kolmogorov-Smirnov 5% Critical Value	0.2452063	95% BCA Bootstrap UCL	839.88583
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	975.9901
		97.5% Chebyshev(Mean, Sd) UCL	1,074.49
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	1,267.97
95% Approximate Gamma UCL	850.5682		
95% Adjusted Gamma UCL	867.53736		
Potential UCL to Use		Use 95% Student's-t UCL	842.13868

Thallium (mg/kg)

General Statistics

Number of Valid Data	5	Number of Detected Data	1
Number of Distinct Detected Data	1	Number of Non-Detect Data	4
		Percent Non-Detects	80.00%

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g.

The data set for variable Thallium (mg/kg) was not processed!

Vanadium (mg/kg)

General Statistics

Number of Valid Observations	9	Number of Distinct Observations	9
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Raw Statistics

Minimum	18.389
Maximum	48.7
Mean	27.405889
Median	25.438
SD	8.3864318
Coefficient of Variation	0.3060084
Skewness	2.4121549

Log-transformed Statistics

Minimum of Log Data	2.9117527
Maximum of Log Data	3.885679
Mean of log Data	3.2783291
SD of log Data	0.2552321

Warning: There are only 9 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set, the resulting calculations may not be reliable enough to draw conclusions

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit K
 St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics**Normal Distribution Test**

Shapiro Wilk Test Statistic

0.6562543

Shapiro Wilk Critical Value

0.829

Data not Normal at 5% Significance Level**Lognormal Distribution Test**

Shapiro Wilk Test Statistic

0.7534618

Shapiro Wilk Critical Value

0.829

Data not Lognormal at 5% Significance Level**Assuming Normal Distribution**

95% Student's-t UCL

32.604213

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL

34.405748

95% Modified-t UCL

32.978831

Assuming Lognormal Distribution

95% H-UCL

32.721066

95% Chebyshev (MVUE) UCL

37.477946

97.5% Chebyshev (MVUE) UCL

41.878268

99% Chebyshev (MVUE) UCL

50.52185

Gamma Distribution Test

k star (bias corrected)

10.462885

Theta Star

2.6193434

nu star

188.33193

Approximate Chi Square Value (.05)

157.58568

Adjusted Level of Significance

0.02308

Adjusted Chi Square Value

151.65085

Data Distribution**Data do not follow a Discernable Distribution (0.05)****Nonparametric Statistics**

95% CLT UCL

32.00404

95% Jackknife UCL

32.604213

95% Standard Bootstrap UCL

31.794299

95% Bootstrap-t UCL

42.021494

95% Hall's Bootstrap UCL

55.124599

95% Percentile Bootstrap UCL

32.509889

95% BCA Bootstrap UCL

33.503556

Anderson-Darling Test Statistic

1.2709095

Anderson-Darling 5% Critical Value

0.7213145

Kolmogorov-Smirnov Test Statistic

0.3670025

Kolmogorov-Smirnov 5% Critical Value

0.2790576

Data not Gamma Distributed at 5% Significance Level

95% Chebyshev(Mean, Sd) UCL

39.591092

97.5% Chebyshev(Mean, Sd) UCL

44.863639

99% Chebyshev(Mean, Sd) UCL

55.220537

Assuming Gamma Distribution

95% Approximate Gamma UCL

32.753002

95% Adjusted Gamma UCL

34.034785

Potential UCL to Use

Use 95% Student's-t UCL

32.604213

or 95% Modified-t UCL

32.978831

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit L

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Summary Statistics for Raw Data Sets with NDs using Detected Data Only

				Raw Statistics using Detected Observations							
Variable	Num Ds	NumNDs	% NDs	Minimum	Maximum	Mean	Median	SD	MAD/0.675	Skewness	CV
Aluminum (mg/kg)	6	0	0.00%	5,510.80	8,681	7,523.13	8022	1,298.61	894.73684	-0.936891	0.172616
cis-1,2-Dichloroethene (mg/kg)	13	5	27.78%	0.00067	0.7	0.12149	0.032	0.219306	0.0449222	2.2134887	1.805133
Iron (mg/kg)	8	0	0.00%	4,900	23,197	14,363.88	15,588	5,195.01	2,925.87	-0.244585	0.361672
Lead (mg/kg)	8	0	0.00%	14.9	510	136.8375	82.5	159.9379	77.909563	2.2424382	1.168816
Manganese (mg/kg)	7	0	0.00%	528.3	1,050	719.61429	665	187.5628	109.7109	1.1361335	0.260644
Selenium (mg/kg)	3	3	50.00%	0.6	6.42	4.2233333	5.65	3.161429	1.1415864	-1.617176	0.748563
Tetrachloroethene (mg/kg)	17	1	5.56%	0.00046	6.4	0.7705212	0.048	1.865808	0.0693847	2.6586546	2.421488
Thallium (mg/kg)	2	3	60.00%	2.23	2.36	2.295	2.295	0.091924	0.0963677	N/A	0.040054
Trichloroethene (mg/kg)	13	5	27.78%	0.0011	0.81	0.1723692	0.032	0.275703	0.0378058	1.6055943	1.599491
Vanadium (mg/kg)	6	0	0.00%	19.7	51.2	28.416667	25.9	11.62677	5.1890289	2.0221477	0.409153

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit L

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

Full Precision	ON	
Confidence Coefficient	95%	
Number of Bootstrap Operations		2,000

Aluminum (mg/kg)

General Statistics

Number of Valid Observations	6	Number of Distinct Observations	6
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Raw Statistics

Minimum	5510.8
Maximum	8,681
Mean	7523.1333
Median	8,022
SD	1298.6128
Coefficient of Variation	0.1726159
Skewness	-0.936891

Log-transformed Statistics

Minimum of Log Data	8.6144651
Maximum of Log Data	9.068892
Mean of log Data	8.9120915
SD of log Data	0.1852582

Warning: A sample size of 'n' = 6 may not adequate enough to compute meaningful and reliable test statistics and estimates!

It is suggested to collect at least 8 to 10 observations using these statistical methods!

If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Warning: There are only 6 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set, the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic	0.8572219
Shapiro Wilk Critical Value	0.788

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Shapiro Wilk Test Statistic	0.8409044
Shapiro Wilk Critical Value	0.788

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	8,591.42
95% UCLs (Adjusted for Skewness)	
95% Adjusted-CLT UCL	8,178.49
95% Modified-t UCL	8,557.63

Assuming Lognormal Distribution

95% H-UCL	8,945.99
95% Chebyshev (MVUE) UCL	10,009.46
97.5% Chebyshev (MVUE) UCL	11,083.26
99% Chebyshev (MVUE) UCL	13,192.54

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit L
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Gamma Distribution Test

k star (bias corrected) 18.513737
Theta Star 406.35412
nu star 222.16485
Approximate Chi Square Value (.05) 188.66645
Adjusted Level of Significance 0.01222
Adjusted Chi Square Value 177.46331

Data Distribution

Data appear Normal at 5% Significance Level

Nonparametric Statistics

Anderson-Darling Test Statistic 0.5455101
Anderson-Darling 5% Critical Value 0.6969724
Kolmogorov-Smirnov Test Statistic 0.3037269
Kolmogorov-Smirnov 5% Critical Value 0.3317748
Data appear Gamma Distributed at 5% Significance Level

95% CLT UCL 8,395.16
95% Jackknife UCL 8,591.42
95% Standard Bootstrap UCL 8,313.57
95% Bootstrap-t UCL 8,374.82
95% Hall's Bootstrap UCL 8,090.43
95% Percentile Bootstrap UCL 8,330.50
95% BCA Bootstrap UCL 8,181.17
95% Chebyshev(Mean, Sd) UCL 9,834.03
97.5% Chebyshev(Mean, Sd) UCL 10,833.96
99% Chebyshev(Mean, Sd) UCL 12,798.12

Assuming Gamma Distribution

95% Approximate Gamma UCL 8,858.89
95% Adjusted Gamma UCL 9418.148

Potential UCL to Use

Use 95% Student's-t UCL 8,591.42

cis-1,2-Dichloroethene (mg/kg)**General Statistics**

Number of Valid Data
Number of Distinct Detected Data

18 Number of Detected Data 13
13 Number of Non-Detect Data 5
Percent Non-Detects 27.78%

Raw Statistics

Minimum Detected
Maximum Detected
Mean of Detected
SD of Detected
Minimum Non-Detect
Maximum Non-Detect

Log-transformed Statistics

0.00067 Minimum Detected -7.308233
0.7 Maximum Detected -0.356675
0.12149 Mean of Detected -3.827007
0.2193057 SD of Detected 2.2554696
0.0062 Minimum Non-Detect -5.083206
0.0065 Maximum Non-Detect -5.035953

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect 8
Number treated as Detected 10
Single DL Non-Detect Percentage 44.44%

UCL Statistics**Normal Distribution Test with Detected Values Only**

Shapiro Wilk Test Statistic 0.6032768
5% Shapiro Wilk Critical Value 0.866
Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic 0.9532372
5% Shapiro Wilk Critical Value 0.866
Data appear Lognormal at 5% Significance Level

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit L
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Assuming Normal Distribution

DL/2 Substitution Method

Mean	0.0886261	Mean
SD	0.1921527	SD
95% DL/2 (t) UCL	0.1674143	95% H-Stat (DL/2) UCL

Maximum Likelihood Estimate(MLE) Method

MLE yields a negative mean

N/A

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean	-4.361464
SD	2.0922215
95% H-Stat (DL/2) UCL	0.5265474
Log ROS Method	
Mean in Log Scale	-4.676701
SD in Log Scale	2.3862091
Mean in Original Scale	0.088084
SD in Original Scale	0.1924103
95% Percentile Bootstrap UCL	0.1689061
95% BCA Bootstrap UCL	0.1872767

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.3475374
Theta Star	0.3495739
nu star	9.0359729

Data Distribution Test with Detected Values Only

Data appear Gamma Distributed at 5% Significance Level

A-D Test Statistic

5% A-D Critical Value

K-S Test Statistic

5% K-S Critical Value

0.4142377 **Nonparametric Statistics**

0.8128375 Kaplan-Meier (KM) Method

0.8128375 Mean

0.2535604 SD

0.088027

0.1870154

Data appear Gamma Distributed at 5% Significance Level

SE of Mean

0.04588

95% KM (t) UCL

0.1678402

95% KM (z) UCL

0.1634929

95% KM (jackknife) UCL

0.1669324

1E-09 95% KM (bootstrap t) UCL

0.461435

0.7 95% KM (BCA) UCL

0.1664778

0.0887108 95% KM (Percentile Bootstrap) UCL

0.1688389

0.008712 95% KM (Chebyshev) UCL

0.2880133

0.1921268 97.5% KM (Chebyshev) UCL

0.3745475

0.1819924 99% KM (Chebyshev) UCL

0.5445272

0.4874422

6.5517267 **Potential UCLs to Use**

1.9280089 95% KM (Chebyshev) UCL

0.2880133

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum

Maximum

Mean

Median

SD

k star

Theta star

Nu star

AppChi2

95% Gamma Approximate UCL

95% Adjusted Gamma UCL

0.3014554

0.3424462

Note: DL/2 is not a recommended method.

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit L
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Iron (mg/kg)

General Statistics

Number of Valid Observations

8 Number of Distinct Observations

8

Raw Statistics

Minimum

4,900 Minimum of Log Data

8.4969905

Maximum

23,197 Maximum of Log Data

10.051778

Mean

14,363.88 Mean of log Data

9.4965839

Median

15,588 SD of log Data

0.4557082

SD

5,195.01

Coefficient of Variation

0.3616718

Skewness

-0.244585

Log-transformed Statistics

Warning: There are only 8 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set, the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic

0.9200822 Shapiro Wilk Test Statistic

0.8237859

Shapiro Wilk Critical Value

0.818 Shapiro Wilk Critical Value

0.818

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL

17,843.67 95% H-UCL

21,878.90

95% UCLs (Adjusted for Skewness)

95% Chebyshev (MVUE) UCL

24,885.95

95% Adjusted-CLT UCL

17,215.29 97.5% Chebyshev (MVUE) UCL

29,350.79

95% Modified-t UCL

17,817.20 99% Chebyshev (MVUE) UCL

38,121.11

Assuming Lognormal Distribution

Gamma Distribution Test

k star (bias corrected)

4.3026967 **Data appear Normal at 5% Significance Level**

Theta Star

3,338.34

nu star

68.843147

Approximate Chi Square Value (.05)

50.744461 **Nonparametric Statistics**

Adjusted Level of Significance

0.01946 95% CLT UCL

17,385.00

Adjusted Chi Square Value

46.836496 95% Jackknife UCL

17,843.67

95% Standard Bootstrap UCL

17,225.55

Anderson-Darling Test Statistic

0.612372 95% Bootstrap-t UCL

17,451.58

Anderson-Darling 5% Critical Value

0.7176342 95% Hall's Bootstrap UCL

17,746.24

Kolmogorov-Smirnov Test Statistic

0.2531795 95% Percentile Bootstrap UCL

17,205

Kolmogorov-Smirnov 5% Critical Value

0.2949038 95% BCA Bootstrap UCL

17,144

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit L
 St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	22,369.92
		97.5% Chebyshev(Mean, Sd) UCL	25,834.14
Assuming Gamma Distribution		99% Chebyshev(Mean, Sd) UCL	32,638.94
95% Approximate Gamma UCL	19,486.94		
95% Adjusted Gamma UCL	21,112.90		

Potential UCL to Use	Use 95% Student's-t UCL	17,843.67
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Lead (mg/kg)

General Statistics

Number of Valid Observations	8 Number of Distinct Observations	7
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Raw Statistics

Minimum	14.9 Minimum of Log Data	2.7013612
Maximum	510 Maximum of Log Data	6.2344107
Mean	136.8375 Mean of log Data	4.4158728
Median	82.5 SD of log Data	1.0899094
SD	159.93785	
Coefficient of Variation	1.168816	
Skewness	2.2424382	

Log-transformed Statistics

Warning: There are only 8 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set, the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics**Normal Distribution Test**

Shapiro Wilk Test Statistic	0.7255947 Shapiro Wilk Test Statistic	0.9848495
Shapiro Wilk Critical Value	0.818 Shapiro Wilk Critical Value	0.818

Lognormal Distribution Test

Data not Normal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL	243.96942	95% H-UCL	674.35778
95% UCLs (Adjusted for Skewness)		95% Chebyshev (MVUE) UCL	367.79725
95% Adjusted-CLT UCL	277.75127	97.5% Chebyshev (MVUE) UCL	468.31988
95% Modified-t UCL	251.44131	99% Chebyshev (MVUE) UCL	665.77713

Assuming Lognormal Distribution**Gamma Distribution Test**

k star (bias corrected)	0.7906851	Data appear Gamma Distributed at 5% Significance Level
Theta Star	173.06194	
nu star	12.650962	

Data Distribution

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit L
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Approximate Chi Square Value (.05)	5.6587924	Nonparametric Statistics	
Adjusted Level of Significance	0.01946	95% CLT UCL	229.84833
Adjusted Chi Square Value	4.5324735	95% Jackknife UCL	243.96942
		95% Standard Bootstrap UCL	223.72613
Anderson-Darling Test Statistic	0.2778644	95% Bootstrap-t UCL	404.01421
Anderson-Darling 5% Critical Value	0.7336342	95% Hall's Bootstrap UCL	622.77982
Kolmogorov-Smirnov Test Statistic	0.1504973	95% Percentile Bootstrap UCL	241.9625
Kolmogorov-Smirnov 5% Critical Value	0.3007854	95% BCA Bootstrap UCL	279.35
Data appear Gamma Distributed at 5% Significance Level		95% Chebyshev(Mean, Sd) UCL	383.31829
		97.5% Chebyshev(Mean, Sd) UCL	489.97072
		99% Chebyshev(Mean, Sd) UCL	699.46877
Assuming Gamma Distribution			
95% Approximate Gamma UCL	305.91792		
95% Adjusted Gamma UCL	381.93847		

Potential UCL to Use Use 95% Approximate Gamma UCL 305.91792

Manganese (mg/kg)

General Statistics

Number of Valid Observations 7 Number of Distinct Observations 7

Raw Statistics

Minimum	528.3	Minimum of Log Data	6.2696643
Maximum	1050	Maximum of Log Data	6.9565454
Mean	719.61429	Mean of log Data	6.5521258
Median	665	SD of log Data	0.2435909
SD	187.56281		
Coefficient of Variation	0.2606435		
Skewness	1.1361335		

Log-transformed Statistics

Warning: A sample size of 'n' = 7 may not adequate enough to compute meaningful and reliable test statistics and estimates!

It is suggested to collect at least 8 to 10 observations using these statistical methods!
If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Warning: There are only 7 Values in this data

Note: It should be noted that even though bootstrap methods may be performed on this data set,
the resulting calculations may not be reliable enough to draw conclusions

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic
Shapiro Wilk Critical Value

Data appear Normal at 5% Significance Level

Lognormal Distribution Test

0.8674992 Shapiro Wilk Test Statistic
0.803 Shapiro Wilk Critical Value

Data appear Lognormal at 5% Significance Level

0.909243
0.803

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit L
 St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Assuming Normal Distribution

95% Student's-t UCL

857.37033

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL

868.74946

95% Modified-t UCL

862.44405

Assuming Lognormal Distribution

95% H-UCL

887.24938

95% Chebyshev (MVUE) UCL

1,007.59

97.5% Chebyshev (MVUE) UCL

1,132.58

99% Chebyshev (MVUE) UCL

1,378.10

Gamma Distribution Test

k star (bias corrected)

10.934997

Theta Star

65.808364

nu star

153.08996

Approximate Chi Square Value (.05)

125.48936

Adjusted Level of Significance

0.01584

Adjusted Chi Square Value

117.9371

Data Distribution**Data appear Normal at 5% Significance Level****Nonparametric Statistics**

95% CLT UCL

836.22138

95% Jackknife UCL

857.37033

95% Standard Bootstrap UCL

829.45307

95% Bootstrap-t UCL

1,082.52

95% Hall's Bootstrap UCL

1,816.43

95% Percentile Bootstrap UCL

828.42857

95% BCA Bootstrap UCL

853.18571

Anderson-Darling Test Statistic

0.4628018

Anderson-Darling 5% Critical Value

0.7068655

Kolmogorov-Smirnov Test Statistic

0.2906035

Kolmogorov-Smirnov 5% Critical Value

0.3115084

Data appear Gamma Distributed at 5% Significance Level

95% Chebyshev(Mean, Sd) UCL

1,028.63

97.5% Chebyshev(Mean, Sd) UCL

1,162.34

99% Chebyshev(Mean, Sd) UCL

1,424.98

Assuming Gamma Distribution

95% Approximate Gamma UCL

877.88899

95% Adjusted Gamma UCL

934.10579

Potential UCL to Use

Use 95% Student's-t UCL

857.37033

Selenium (mg/kg)**General Statistics**

Number of Valid Data

6 Number of Detected Data

3

Number of Distinct Detected Data

3 Number of Non-Detect Data

3

Percent Non-Detects

50.00%

Raw Statistics

Minimum Detected

0.6 Minimum Detected

-0.510826

Maximum Detected

6.42 Maximum Detected

1.8594181

Mean of Detected

4.2233333 Mean of Detected

1.0267493

SD of Detected

3.161429 SD of Detected

1.3331104

Minimum Non-Detect

0.25 Minimum Non-Detect

-1.386294

Maximum Non-Detect

0.25 Maximum Non-Detect

-1.386294

Log-transformed Statistics**Warning: There are only 3 Distinct Detected Values in this data set****The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.****Those methods will return a 'N/A' value on your output display!**

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit L
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

It is necessary to have 4 or more Distinct Values for bootstrap methods.

It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic
5% Shapiro Wilk Critical Value
Data appear Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

0.8472484 Shapiro Wilk Test Statistic
0.767 5% Shapiro Wilk Critical Value
Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean 2.1741667
SD 3.0061195
95% DL/2 (t) UCL 4.6471209

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean -0.526346
SD 1.8987891
95% H-Stat (DL/2) UCL 22.698405

Maximum Likelihood Estimate(MLE) Method

Mean 0.3979358
SD 4.6757533
95% MLE (t) UCL 4.2443977
95% MLE (Tiku) UCL 5.1314808

Log ROS Method

Mean in Log Scale -0.908634
SD in Log Scale 2.3909835
Mean in Original Scale 2.1537927
SD in Original Scale 3.0232234
95% Percentile Bootstrap UCL 4.095
95% BCA Bootstrap UCL 4.1908144

Gamma Distribution Test with Detected Values Only

k star (bias corrected) N/A
Theta Star N/A
nu star N/A

Data Distribution Test with Detected Values Only

Data appear Normal at 5% Significance Level

A-D Test Statistic

5% A-D Critical Value N/A
K-S Test Statistic N/A
5% K-S Critical Value N/A

0.5385905 Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean 2.4116667
SD 2.5717077
SE of Mean 1.2858539
95% KM (t) UCL 5.0027244
95% KM (z) UCL 4.526708
95% KM (jackknife) UCL 6.106656
95% KM (bootstrap t) UCL 3.5048566
95% KM (BCA) UCL 6.42
95% KM (Percentile Bootstrap) UCL 6.42
95% KM (Chebyshev) UCL 8.0165737
97.5% KM (Chebyshev) UCL 10.441821
99% KM (Chebyshev) UCL 15.205751

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum N/A
Maximum N/A
Mean N/A
Median N/A
SD N/A
k star N/A
Theta star N/A
Nu star N/A
AppChi2 N/A

Potential UCLs to Use

95% KM (t) UCL 5.0027244

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit L
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

95% Gamma Approximate UCL	N/A	95% KM (Percentile Bootstrap) UCL	6.42
95% Adjusted Gamma UCL	N/A		

Note: DL/2 is not a recommended method.

Tetrachloroethene (mg/kg)**General Statistics**

Number of Valid Data	18	Number of Detected Data	17
Number of Distinct Detected Data	15	Number of Non-Detect Data	1
		Percent Non-Detects	5.56%

Raw Statistics

Minimum Detected
Maximum Detected
Mean of Detected
SD of Detected
Minimum Non-Detect
Maximum Non-Detect

Log-transformed Statistics

0.00046	Minimum Detected	-7.684284
6.4	Maximum Detected	1.856298
0.7705212	Mean of Detected	-3.018793
1.8658081	SD of Detected	2.7011372
0.0063	Minimum Non-Detect	-5.067206
0.0063	Maximum Non-Detect	-5.067206

UCL Statistics**Normal Distribution Test with Detected Values Only**

Shapiro Wilk Test Statistic
5% Shapiro Wilk Critical Value

0.4673655	Shapiro Wilk Test Statistic	0.9693862
0.892	5% Shapiro Wilk Critical Value	0.892

Data not Normal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean
SD

95% DL/2 (t) UCL

Assuming Lognormal Distribution

DL/2 Substitution Method

0.7278894	Mean	-3.171102
1.8191139	SD	2.6989852
1.4737793	95% H-Stat (DL/2) UCL	46.003473

Maximum Likelihood Estimate(MLE) Method

Mean
SD

95% MLE (t) UCL

95% MLE (Tiku) UCL

Log ROS Method

0.3891847	Mean in Log Scale	-3.236533
2.081343	SD in Log Scale	2.7785512
1.2425961	Mean in Original Scale	0.7277683
1.2322288	SD in Original Scale	1.8191651
	95% Percentile Bootstrap UCL	1.4737556
	95% BCA Bootstrap UCL	1.7932856

Gamma Distribution Test with Detected Values Only

k star (bias corrected)
Theta Star
nu star

0.2504248	Data Follow Appr. Gamma Distribution at 5% Significance Level
3.0768565	
8.5144431	

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit L
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

A-D Test Statistic	1.1197895	Nonparametric Statistics	
5% A-D Critical Value	0.8595758	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.8595758	Mean	0.7277674
5% K-S Critical Value	0.2288091	SD	1.7679111
Data follow Appr. Gamma Distribution at 5% Significance Level	SE of Mean		0.4295252
	95% KM (t) UCL		1.4749722
Assuming Gamma Distribution	95% KM (z) UCL		1.4342735
Gamma ROS Statistics using Extrapolated Data	95% KM (jackknife) UCL		1.4736784
Minimum	1E-09	95% KM (bootstrap t) UCL	6.9804823
Maximum	6.4	95% KM (BCA) UCL	1.5205272
Mean	0.7277144	95% KM (Percentile Bootstrap) UCL	1.4931478
Median	0.038	95% KM (Chebyshev) UCL	2.6000243
SD	1.8191879	97.5% KM (Chebyshev) UCL	3.4101513
k star	0.2035109	99% KM (Chebyshev) UCL	5.001489
Theta star	3.5758006		
Nu star	7.3263929	Potential UCLs to Use	
AppChi2	2.3514201	95% KM (Chebyshev) UCL	2.6000243
95% Gamma Approximate UCL	2.2673626		
95% Adjusted Gamma UCL	2.5510703		

Note: DL/2 is not a recommended method.

Thallium (mg/kg)

General Statistics

Number of Valid Data	5	Number of Detected Data	2
Number of Distinct Detected Data	2	Number of Non-Detect Data	3
		Percent Non-Detects	60.00%

Raw Statistics

Minimum Detected	2.23	Minimum Detected	0.8020016
Maximum Detected	2.36	Maximum Detected	0.8586616
Mean of Detected	2.295	Mean of Detected	0.8303316
SD of Detected	0.0919239	SD of Detected	0.0400647
Minimum Non-Detect	31.3	Minimum Non-Detect	3.4436181
Maximum Non-Detect	31.3	Maximum Non-Detect	3.4436181

Log-transformed Statistics

Warning: Data set has only 2 Distinct Detected Values.

This may not be adequate enough to compute meaningful and reliable test statistics and estimates.

The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

Unless Data Quality Objectives (DQOs) have been met, it is suggested to collect additional observations.

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit L
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.
Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.
It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic
5% Shapiro Wilk Critical Value
Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

0.9999808 Shapiro Wilk Test Statistic
N/A 5% Shapiro Wilk Critical Value
Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean 10.308
SD 7.3149792
95% DL/2 (t) UCL 17.282032

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean 1.9824152
SD 1.0518944
95% H-Stat (DL/2) UCL 30,500.04

Maximum Likelihood Estimate(MLE) Method

MLE method failed to converge properly

N/A

Log ROS Method

Mean in Log Scale N/A
SD in Log Scale N/A
Mean in Original Scale N/A
SD in Original Scale N/A
95% Percentile Bootstrap UCL N/A
95% BCA Bootstrap UCL N/A

Gamma Distribution Test with Detected Values Only

k star (bias corrected) N/A
Theta Star N/A
nu star N/A

Data Distribution Test with Detected Values Only

Data do not follow a Discernable Distribution (0.05)

A-D Test Statistic

5% A-D Critical Value

K-S Test Statistic

5% K-S Critical Value

Data not Gamma Distributed at 5% Significance Level

0.3593681 Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean 2.295

SD 0.065

SE of Mean 0.065

95% KM (t) UCL 2.43357

95% KM (z) UCL 2.4019155

95% KM (jackknife) UCL N/A

95% KM (bootstrap t) UCL N/A

95% KM (BCA) UCL N/A

95% KM (Percentile Bootstrap) UCL N/A

95% KM (Chebyshev) UCL 2.5783284

97.5% KM (Chebyshev) UCL 2.7009249

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum N/A

Maximum N/A

Mean N/A

Median N/A

SD N/A

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit L
 St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

k star	N/A	99% KM (Chebyshev) UCL	2.9417418
Theta star	N/A		
Nu star	N/A	Potential UCLs to Use	
AppChi2	N/A	95% KM (t) UCL	2.43357
95% Gamma Approximate UCL	N/A	95% KM (% Bootstrap) UCL	N/A
95% Adjusted Gamma UCL	N/A		

Warning: Recommended UCL exceeds the maximum observation

Note: DL/2 is not a recommended method.

Trichloroethene (mg/kg)

General Statistics

Number of Valid Data	18	Number of Detected Data	13
Number of Distinct Detected Data	13	Number of Non-Detect Data	5
		Percent Non-Detects	27.78%

Raw Statistics

Minimum Detected
 Maximum Detected
 Mean of Detected
 SD of Detected
 Minimum Non-Detect
 Maximum Non-Detect

Log-transformed Statistics

0.0011	Minimum Detected	-6.812445
0.81	Maximum Detected	-0.210721
0.1723692	Mean of Detected	-3.347389
0.2757031	SD of Detected	2.0964174
0.006	Minimum Non-Detect	-5.115996
0.0065	Maximum Non-Detect	-5.035953

Note: Data have multiple DLs - Use of KM Method is recommended
 For all methods (except KM, DL/2, and ROS Methods),
 Observations < Largest ND are treated as NDs

	Number treated as Non-Detect	7
	Number treated as Detected	11
	Single DL Non-Detect Percentage	38.89%

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic
 5% Shapiro Wilk Critical Value

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

0.664245	Shapiro Wilk Test Statistic	0.9558095
0.866	5% Shapiro Wilk Critical Value	0.866

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean	0.1253639	Mean	-4.017784
SD	0.2444142	SD	2.0832307
95% DL/2 (t) UCL	0.2255808	95% H-Stat (DL/2) UCL	0.5412908

Assuming Lognormal Distribution

DL/2 Substitution Method

Maximum Likelihood Estimate(MLE) Method

Mean	0.0258544	Mean in Log Scale	-4.271951
SD	0.3340986	SD in Log Scale	2.3464584
95% MLE (t) UCL	0.1628446	Mean in Original Scale	0.124869

Log ROS Method

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit L
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

95% MLE (Tiku) UCL	0.1782808 SD in Original Scale	0.2446776
	95% Percentile Bootstrap UCL	0.2217525
	95% BCA Bootstrap UCL	0.2407506

Gamma Distribution Test with Detected Values Only

k star (bias corrected)

Theta Star

nu star

Data Distribution Test with Detected Values Only

0.3682619 Data appear Gamma Distributed at 5% Significance Level

0.4680615

9.5748096

A-D Test Statistic

5% A-D Critical Value

K-S Test Statistic

5% K-S Critical Value

0.6189422 Nonparametric Statistics

0.8074693 Kaplan-Meier (KM) Method

0.8074693 Mean

0.2526808 SD

0.1249472

0.2377433

Data appear Gamma Distributed at 5% Significance Level

SE of Mean

0.0583249

95% KM (t) UCL

0.2264097

95% KM (z) UCL

0.2208832

95% KM (jackknife) UCL

0.225256

1E-09 95% KM (bootstrap t) UCL

0.2970244

0.81 95% KM (BCA) UCL

0.2246944

0.1244889 95% KM (Percentile Bootstrap) UCL

0.2295861

0.0115 95% KM (Chebyshev) UCL

0.3791797

0.2448813 97.5% KM (Chebyshev) UCL

0.4891863

0.1444823 99% KM (Chebyshev) UCL

0.705273

0.8616206

5.201361 Potential UCLs to Use

1.2463396 95% KM (Chebyshev) UCL

0.3791797

0.5195307

0.6036433

Note: DL/2 is not a recommended method.

Vanadium (mg/kg)

General Statistics

Number of Valid Observations

6 Number of Distinct Observations

6

Raw Statistics

Minimum

Maximum

Mean

Median

SD

Coefficient of Variation

Skewness

Log-transformed Statistics

19.7 Minimum of Log Data

51.2 Maximum of Log Data

28.416667 Mean of log Data

25.9 SD of log Data

11.626765

0.409153

2.0221477

2.9806186

3.9357395

3.2914622

0.345094

APPENDIX R

ProUCL Output – On-Site Soil (0-10 ft bgs), Exposure Unit L
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Warning: A sample size of 'n' = 6 may not adequate enough to compute meaningful and reliable test statistics and estimates!

It is suggested to collect at least 8 to 10 observations using these statistical methods!

If possible compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Warning: There are only 6 Values in this data

**Note: It should be noted that even though bootstrap methods may be performed on this data set,
the resulting calculations may not be reliable enough to draw conclusions**

The literature suggests to use bootstrap methods on data sets having more than 10-15 observations.

Relevant UCL Statistics

Normal Distribution Test

Shapiro Wilk Test Statistic

0.7444617 Shapiro Wilk Test Statistic

0.8350172

Shapiro Wilk Critical Value

0.788 Shapiro Wilk Critical Value

0.788

Data not Normal at 5% Significance Level

Lognormal Distribution Test

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL

37.981309

95% UCLs (Adjusted for Skewness)

95% Adjusted-CLT UCL

40.411121

95% Modified-t UCL

38.634394

Assuming Lognormal Distribution

95% H-UCL

40.735059

95% Chebyshev (MVUE) UCL

45.576418

97.5% Chebyshev (MVUE) UCL

53.077938

99% Chebyshev (MVUE) UCL

67.813222

Gamma Distribution Test

k star (bias corrected)

4.6962586

Theta Star

6.050916

nu star

56.355104

Approximate Chi Square Value (.05)

40.101096

Adjusted Level of Significance

0.01222

Adjusted Chi Square Value

35.211548

Data Distribution

Data Follow Appr. Gamma Distribution at 5% Significance Level

Nonparametric Statistics

95% CLT UCL

36.22414

95% Jackknife UCL

37.981309

95% Standard Bootstrap UCL

35.452079

95% Bootstrap-t UCL

49.312151

95% Hall's Bootstrap UCL

70.514577

95% Percentile Bootstrap UCL

36.4

95% BCA Bootstrap UCL

38.75

Anderson-Darling Test Statistic

0.6250665

Anderson-Darling 5% Critical Value

0.6982835

Kolmogorov-Smirnov Test Statistic

0.3329287

Kolmogorov-Smirnov 5% Critical Value

0.3325314

Data follow Appr. Gamma Distribution at 5% Significance Level

95% Chebyshev(Mean, Sd) UCL

49.106647

97.5% Chebyshev(Mean, Sd) UCL

58.059218

99% Chebyshev(Mean, Sd) UCL

75.64481

Assuming Gamma Distribution

95% Approximate Gamma UCL

39.934674

95% Adjusted Gamma UCL

45.480086

Potential UCL to Use

Use 95% Approximate Gamma UCL

39.934674

APPENDIX R

ProUCL Output – Downgradient Former Building 220 Groundwater (Excavations)

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Summary Statistics for Raw Data Sets with NDs using Detected Data Only

				Raw Statistics using Detected Observations							
Variable	Num Ds	NumNDs	% NDs	Minimum	Maximum	Mean	Median	SD	MAD/0.675	Skewness	CV
1,1,1,2-Tetrachloroethane	1	5	83.33%	16	16	16	16	N/A	0	N/A	N/A
1,1,2,2-Tetrachloroethane	1	3	75.00%	0.58	0.58	0.58	0.58	N/A	0	N/A	N/A
1,1,2-Trichloroethane	1	3	75.00%	2.3	2.3	2.3	2.3	N/A	0	N/A	N/A
1,2-Dichloroethane (EDC)	2	4	66.67%	3.3	189	96.15	96.15	131.3	137.7	N/A	1.366
Benzene	2	4	66.67%	0.22	4	2.11	2.11	2.673	2.802	N/A	1.267
Carbon tetrachloride	2	4	66.67%	2.7	4,160	2,081	2,081	2,940	3,082	N/A	1.412
Chloroform	3	2	40.00%	20	790	277.9	23.8	443.5	5.634	1.732	1.596
cis-1,2-Dichloroethene	2	3	60.00%	250	281	265.5	265.5	21.92	22.98	N/A	0.0826
Naphthalene	1	3	75.00%	10.1	10.1	10.1	10.1	N/A	0	N/A	N/A
Tetrachloroethene	6	2	25.00%	0.64	34,900	10,651	2.94	16,603	3.284	1.023	1.559
trans-1,2-Dichloroethene	1	4	80.00%	12	12	12	12	N/A	0	N/A	N/A
Trichloroethene	5	2	28.57%	0.41	1620	812.2	1040	769.4	859.9	-0.3	0.947
Vinyl chloride	1	0	0.00%	0.32	0.32	0.32	0.32	N/A	0	N/A	N/A

APPENDIX R

ProUCL Output – Downgradient Former Building 220 Groundwater (Excavations)
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

Full Precision	OFF	
Confidence Coefficient	95%	
Number of Bootstrap Operations		2,000

1,1,1,2-Tetrachloroethane

General Statistics

Number of Valid Data	6 Number of Detected Data	1
Number of Distinct Detected Data	1 Number of Non-Detect Data	5
Number of Missing Values	42 Percent Non-Detects	83.33%

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set! It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTV).

The data set for variable 1,1,1,2-Tetrachloroethane was not processed!

1,1,2,2-Tetrachloroethane

General Statistics

Number of Valid Data	4 Number of Detected Data	1
Number of Distinct Detected Data	1 Number of Non-Detect Data	3
	Percent Non-Detects	75.00%

Warning: This data set only has 4 observations!

Data set is too small to compute reliable and meaningful statistics and estimates!

The data set for variable 1,1,2,2-Tetrachloroethane was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!

If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

1,1,2-Trichloroethane

General Statistics

Number of Valid Data	4 Number of Detected Data	1
Number of Distinct Detected Data	1 Number of Non-Detect Data	3
	Percent Non-Detects	75.00%

Warning: This data set only has 4 observations!

Data set is too small to compute reliable and meaningful statistics and estimates!

The data set for variable 1,1,2-Trichloroethane was not processed!

APPENDIX R

ProUCL Output – Downgradient Former Building 220 Groundwater (Excavations)

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

It is suggested to collect at least 8 to 10 observations before using these statistical methods!

If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

1,2-Dichloroethane (EDC)

General Statistics

Number of Valid Data	6 Number of Detected Data	2
Number of Distinct Detected Data	2 Number of Non-Detect Data	4
	Percent Non-Detects	66.67%

Raw Statistics

Minimum Detected
Maximum Detected
Mean of Detected
SD of Detected
Minimum Non-Detect
Maximum Non-Detect

Log-transformed Statistics

3.3 Minimum Detected 1.194
189 Maximum Detected 5.242
96.15 Mean of Detected 3.218
131.3 SD of Detected 2.862
1 Minimum Non-Detect 0
50 Maximum Non-Detect 3.912

Note: Data have multiple DLs - Use of KM Method is recommended

For all methods (except KM, DL/2, and ROS Methods),

Observations < Largest ND are treated as NDs

Number treated as Non-Detect

Number treated as Detected

Single DL Non-Detect Percentage

5

1

83.33%

Warning: Data set has only 2 Distinct Detected Values.

This may not be adequate enough to compute meaningful and reliable test statistics and estimates.

The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

Unless Data Quality Objectives (DQOs) have been met, it is suggested to collect additional observations.

The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.

Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.

It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic

5% Shapiro Wilk Critical Value

Data not Normal at 5% Significance Level

N/A

Lognormal Distribution Test with Detected Values Only

1 Shapiro Wilk Test Statistic

5% Shapiro Wilk Critical Value

Data not Lognormal at 5% Significance Level

1

N/A

Assuming Normal Distribution

DL/2 Substitution Method

Mean

SD

95% DL/2 (t) UCL

36.8 Mean

75.15 SD

98.62 95% H-Stat (DL/2) UCL

Assuming Lognormal Distribution

DL/2 Substitution Method

1.531

2.324

14,493

APPENDIX R

ProUCL Output – Downgradient Former Building 220 Groundwater (Excavations)

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	N/A
		SD in Log Scale	N/A
		Mean in Original Scale	N/A
		SD in Original Scale	N/A
		95% Percentile Bootstrap UCL	N/A
		95% BCA Bootstrap UCL	N/A
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	N/A	Data do not follow a Discernable Distribution (0.05)	
Theta Star	N/A		
nu star	N/A		
A-D Test Statistic		0.355 Nonparametric Statistics	
5% A-D Critical Value	N/A	Kaplan-Meier (KM) Method	
K-S Test Statistic	N/A	Mean	34.25
5% K-S Critical Value	N/A	SD	69.21
Data not Gamma Distributed at 5% Significance Level		SE of Mean	39.96
		95% KM (t) UCL	114.8
		95% KM (z) UCL	99.97
		95% KM (jackknife) UCL	179.4
		95% KM (bootstrap t) UCL	1.8E+308
		95% KM (BCA) UCL	N/A
		95% KM (Percentile Bootstrap) UCL	189
		95% KM (Chebyshev) UCL	208.4
		97.5% KM (Chebyshev) UCL	283.8
		99% KM (Chebyshev) UCL	431.8
Assuming Gamma Distribution		Potential UCLs to Use	
Gamma ROS Statistics using Extrapolated Data		99% KM (Chebyshev) UCL	431.8
Minimum	N/A		
Maximum	N/A		
Mean	N/A		
Median	N/A		
SD	N/A		
k star	N/A		
Theta star	N/A		
Nu star	N/A		
AppChi2	N/A		
95% Gamma Approximate UCL	N/A		
95% Adjusted Gamma UCL	N/A		
Warning: Recommended UCL exceeds the maximum observation			
Note: DL/2 is not a recommended method.			

Benzene

General Statistics

Number of Valid Data	6	Number of Detected Data	2
Number of Distinct Detected Data	2	Number of Non-Detect Data	4
		Percent Non-Detects	66.67%

APPENDIX R

ProUCL Output – Downgradient Former Building 220 Groundwater (Excavations)

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Raw Statistics

Minimum Detected
Maximum Detected
Mean of Detected
SD of Detected
Minimum Non-Detect
Maximum Non-Detect

Log-transformed Statistics

0.22 Minimum Detected -1.514
4 Maximum Detected 1.386
2.11 Mean of Detected -0.0639
2.673 SD of Detected 2.051
1 Minimum Non-Detect 0
50 Maximum Non-Detect 3.912

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect 6
Number treated as Detected 0
Single DL Non-Detect Percentage 100.00%

Warning: Data set has only 2 Distinct Detected Values.

This may not be adequate enough to compute meaningful and reliable test statistics and estimates.

The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

Unless Data Quality Objectives (DQOs) have been met, it is suggested to collect additional observations.

The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.

Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.

It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic
5% Shapiro Wilk Critical Value

N/A

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

1 Shapiro Wilk Test Statistic
5% Shapiro Wilk Critical Value

1

N/A

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean

5.453 Mean

0.437

SD

9.689 SD

1.745

95% DL/2 (t) UCL

13.42 95% H-Stat (DL/2) UCL

604.5

Maximum Likelihood Estimate(MLE) Method

N/A

MLE method failed to converge properly

Log ROS Method

Mean in Log Scale

N/A

SD in Log Scale

N/A

Mean in Original Scale

N/A

SD in Original Scale

N/A

95% Percentile Bootstrap UCL

N/A

95% BCA Bootstrap UCL

N/A

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ProUCL Output – Downgradient Former Building 220 Groundwater (Excavations)
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	N/A
Theta Star	N/A
nu star	N/A

Data Distribution Test with Detected Values Only

Data do not follow a Discernable Distribution (0.05)

A-D Test Statistic

0.356 Nonparametric Statistics

5% A-D Critical Value

N/A

Kaplan-Meier (KM) Method

K-S Test Statistic

N/A

Mean

1.165

5% K-S Critical Value

N/A

SD

1.637

Data not Gamma Distributed at 5% Significance Level

SE of Mean

1.157

95% KM (t) UCL

3.497

95% KM (z) UCL

3.069

95% KM (jackknife) UCL

4.291

95% KM (bootstrap t) UCL

1.8E+308

95% KM (BCA) UCL

4

95% KM (Percentile Bootstrap) UCL

N/A

95% KM (Chebyshev) UCL

6.21

97.5% KM (Chebyshev) UCL

8.393

99% KM (Chebyshev) UCL

12.68

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum

N/A

Maximum

N/A

Mean

N/A

Median

N/A

SD

N/A

k star

N/A

Theta star

N/A

Nu star

N/A

AppChi2

N/A

Potential UCLs to Use

95% Gamma Approximate UCL

N/A

99% KM (Chebyshev) UCL

12.68

95% Adjusted Gamma UCL

N/A

Warning: Recommended UCL exceeds the maximum observation

Note: DL/2 is not a recommended method.

Carbon tetrachloride

General Statistics

Number of Valid Data

6 Number of Detected Data

2

Number of Distinct Detected Data

2 Number of Non-Detect Data

4

Percent Non-Detects

66.67%

Raw Statistics

Minimum Detected

2.7 Minimum Detected

0.993

Maximum Detected

4,160 Maximum Detected

8.333

Mean of Detected

2,081 Mean of Detected

4.663

SD of Detected

2,940 SD of Detected

5.19

Minimum Non-Detect

1 Minimum Non-Detect

0

Maximum Non-Detect

50 Maximum Non-Detect

3.912

Log-transformed Statistics

Note: Data have multiple DLs - Use of KM Method is recommended

Number treated as Non-Detect

5

For all methods (except KM, DL/2, and ROS Methods),

Number treated as Detected

1

Observations < Largest ND are treated as NDs

Single DL Non-Detect Percentage

83.33%

APPENDIX R

ProUCL Output – Downgradient Former Building 220 Groundwater (Excavations)
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Warning: Data set has only 2 Distinct Detected Values.

This may not be adequate enough to compute meaningful and reliable test statistics and estimates.

The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

Unless Data Quality Objectives (DQOs) have been met, it is suggested to collect additional observations.

The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.

Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.

It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic

5% Shapiro Wilk Critical Value

Data not Normal at 5% Significance Level

N/A

Lognormal Distribution Test with Detected Values Only

1 Shapiro Wilk Test Statistic

1

5% Shapiro Wilk Critical Value

N/A

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean

SD

95% DL/2 (t) UCL

698.5 Mean

1696 SD

2094 95% H-Stat (DL/2) UCL

2.013

3.414

3.46E+09

Assuming Lognormal Distribution

DL/2 Substitution Method

Maximum Likelihood Estimate(MLE) Method

N/A

MLE method failed to converge properly

Log ROS Method

Mean in Log Scale

SD in Log Scale

Mean in Original Scale

SD in Original Scale

95% Percentile Bootstrap UCL

95% BCA Bootstrap UCL

N/A

N/A

N/A

N/A

N/A

N/A

Gamma Distribution Test with Detected Values Only

k star (bias corrected)

Theta Star

nu star

N/A

N/A

N/A

Data Distribution Test with Detected Values Only

Data do not follow a Discernable Distribution (0.05)

A-D Test Statistic

5% A-D Critical Value

K-S Test Statistic

5% K-S Critical Value

Data not Gamma Distributed at 5% Significance Level

0.368 **Nonparametric Statistics**

Kaplan-Meier (KM) Method

Mean

SD

SE of Mean

95% KM (t) UCL

695.6

1549

894.5

2,498

APPENDIX R

ProUCL Output – Downgradient Former Building 220 Groundwater (Excavations)
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Assuming Gamma Distribution		95% KM (z) UCL	2,167
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	3,946
Minimum	N/A	95% KM (bootstrap't) UCL	1.8E+308
Maximum	N/A	95% KM (BCA) UCL	4,160
Mean	N/A	95% KM (Percentile Bootstrap) UCL	N/A
Median	N/A	95% KM (Chebyshev) UCL	4,595
SD	N/A	97.5% KM (Chebyshev) UCL	6,282
k star	N/A	99% KM (Chebyshev) UCL	9,596
Theta star	N/A		
Nu star	N/A	Potential UCLs to Use	
AppChi2	N/A	99% KM (Chebyshev) UCL	9,596
95% Gamma Approximate UCL	N/A		
95% Adjusted Gamma UCL	N/A		

Warning: Recommended UCL exceeds the maximum observation

Note: DL/2 is not a recommended method.

Chloroform

General Statistics

Number of Valid Data	5 Number of Detected Data	3
Number of Distinct Detected Data	3 Number of Non-Detect Data	2
	Percent Non-Detects	40.00%

Raw Statistics

Minimum Detected	20 Minimum Detected	2.996
Maximum Detected	790 Maximum Detected	6.672
Mean of Detected	277.9 Mean of Detected	4.279
SD of Detected	443.5 SD of Detected	2.074
Minimum Non-Detect	1 Minimum Non-Detect	0
Maximum Non-Detect	5 Maximum Non-Detect	1.609

Log-transformed Statistics

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	2
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	3
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	40.00%

Warning: There are only 3 Distinct Detected Values in this data set

The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.

Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.

It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic
5% Shapiro Wilk Critical Value

Lognormal Distribution Test with Detected Values Only

0.754 Shapiro Wilk Test Statistic	0.785
0.767 5% Shapiro Wilk Critical Value	0.767

APPENDIX R

ProUCL Output – Downgradient Former Building 220 Groundwater (Excavations)

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Data not Normal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean

SD

95% DL/2 (t) UCL

Maximum Likelihood Estimate(MLE) Method

Mean

SD

95% MLE (t) UCL

95% MLE (Tiku) UCL

Gamma Distribution Test with Detected Values Only

k star (bias corrected)

Theta Star

nu star

A-D Test Statistic

5% A-D Critical Value

K-S Test Statistic

5% K-S Critical Value

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum

Maximum

Mean

Median

SD

k star

Theta star

Nu star

AppChi2

95% Gamma Approximate UCL

95% Adjusted Gamma UCL

Warning: Recommended UCL exceeds the maximum observation

Note: DL/2 is not a recommended method.

Data appear Lognormal at 5% Significance Level

Assuming Lognormal Distribution

DL/2 Substitution Method

167.4 Mean

348.2 SD

499.3 95% H-Stat (DL/2) UCL

2.612

2.772

2.05E+09

Log ROS Method

30.05 Mean in Log Scale

445.8 SD in Log Scale

455.1 Mean in Original Scale

507.4 SD in Original Scale

95% Percentile Bootstrap UCL

95% BCA Bootstrap UCL

1.94

3.523

166.8

348.5

474.1

478.8

Data Distribution Test with Detected Values Only

Data appear Lognormal at 5% Significance Level

N/A

N/A

N/A

0.567 Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean

SD

SE of Mean

95% KM (t) UCL

95% KM (z) UCL

95% KM (jackknife) UCL

95% KM (bootstrap t) UCL

95% KM (BCA) UCL

95% KM (Percentile Bootstrap) UCL

95% KM (Chebyshev) UCL

97.5% KM (Chebyshev) UCL

99% KM (Chebyshev) UCL

N/A

N/A

N/A

N/A

N/A

N/A

N/A

N/A

N/A

N/A

N/A

N/A

N/A

N/A

N/A

N/A

N/A

174.8

307.6

168.5

534

451.9

502

33,232

790

790

909.2

1,227

1,851

Potential UCLs to Use

99% KM (Chebyshev) UCL

1,851

APPENDIX R

ProUCL Output – Downgradient Former Building 220 Groundwater (Excavations)

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

cis-1,2-Dichloroethene

General Statistics

Number of Valid Data	5	Number of Detected Data	2
Number of Distinct Detected Data	2	Number of Non-Detect Data	3
		Percent Non-Detects	60.00%

Raw Statistics

Minimum Detected
Maximum Detected
Mean of Detected
SD of Detected
Minimum Non-Detect
Maximum Non-Detect

Log-transformed Statistics

250 Minimum Detected 5.521
281 Maximum Detected 5.638
265.5 Mean of Detected 5.58
21.92 SD of Detected 0.0827
1 Minimum Non-Detect 0
5 Maximum Non-Detect 1.609

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect 3
Number treated as Detected 2
Single DL Non-Detect Percentage 60.00%

Warning: Data set has only 2 Distinct Detected Values.

This may not be adequate enough to compute meaningful and reliable test statistics and estimates.

The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

Unless Data Quality Objectives (DQOs) have been met, it is suggested to collect additional observations.

**The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.
Those methods will return a 'N/A' value on your output display!**

It is necessary to have 4 or more Distinct Values for bootstrap methods.

It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic
5% Shapiro Wilk Critical Value
Data not Normal at 5% Significance Level

N/A

Lognormal Distribution Test with Detected Values Only

1 Shapiro Wilk Test Statistic
5% Shapiro Wilk Critical Value
Data not Lognormal at 5% Significance Level

N/A

Assuming Normal Distribution

DL/2 Substitution Method
Mean
SD
95% DL/2 (t) UCL

Assuming Lognormal Distribution

DL/2 Substitution Method
106.9 Mean 2.138
145.2 SD 3.21
245.3 95% H-Stat (DL/2) UCL 1.74E+11

APPENDIX R

ProUCL Output – Downgradient Former Building 220 Groundwater (Excavations)

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	N/A
		SD in Log Scale	N/A
		Mean in Original Scale	N/A
		SD in Original Scale	N/A
		95% Percentile Bootstrap UCL	N/A
		95% BCA Bootstrap UCL	N/A
Gamma Distribution Test with Detected Values Only		Data Distribution Test with Detected Values Only	
k star (bias corrected)	N/A	Data do not follow a Discernable Distribution (0.05)	
Theta Star	N/A		
nu star	N/A		
A-D Test Statistic		0.359	Nonparametric Statistics
5% A-D Critical Value	N/A	Kaplan-Meier (KM) Method	
K-S Test Statistic	N/A	Mean	256.2
5% K-S Critical Value	N/A	SD	12.4
Data not Gamma Distributed at 5% Significance Level		SE of Mean	7.842
		95% KM (t) UCL	272.9
Assuming Gamma Distribution		95% KM (z) UCL	269.1
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	282.4
Minimum	N/A	95% KM (bootstrap t) UCL	1.8E+308
Maximum	N/A	95% KM (BCA) UCL	N/A
Mean	N/A	95% KM (Percentile Bootstrap) UCL	281
Median	N/A	95% KM (Chebyshev) UCL	290.4
SD	N/A	97.5% KM (Chebyshev) UCL	305.2
k star	N/A	99% KM (Chebyshev) UCL	334.2
Theta star	N/A		
Nu star	N/A	Potential UCLs to Use	
AppChi2	N/A	95% KM (t) UCL	272.9
95% Gamma Approximate UCL	N/A	95% KM (% Bootstrap) UCL	281
95% Adjusted Gamma UCL	N/A		

Note: DL/2 is not a recommended method.

Naphthalene

General Statistics

Number of Valid Data	4	Number of Detected Data	1
Number of Distinct Detected Data	1	Number of Non-Detect Data	3
		Percent Non-Detects	75.00%

Warning: This data set only has 4 observations!

Data set is too small to compute reliable and meaningful statistics and estimates!

The data set for variable Naphthalene was not processed!

APPENDIX R

ProUCL Output – Downgradient Former Building 220 Groundwater (Excavations)
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

It is suggested to collect at least 8 to 10 observations before using these statistical methods!
If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

Tetrachloroethene

General Statistics

Number of Valid Data	8 Number of Detected Data	6
Number of Distinct Detected Data	6 Number of Non-Detect Data	2
	Percent Non-Detects	25.00%

Raw Statistics

Minimum Detected
Maximum Detected
Mean of Detected
SD of Detected
Minimum Non-Detect
Maximum Non-Detect

Log-transformed Statistics

0.64 Minimum Detected
34900 Maximum Detected
10651 Mean of Detected
16603 SD of Detected
1 Minimum Non-Detect
5 Maximum Non-Detect

-0.446
10.46
3.593
5.299
0
1.609

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect
Number treated as Detected
Single DL Non-Detect Percentage

5
3
62.50%

Warning: There are only 6 Detected Values in this data

**Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions**

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic
5% Shapiro Wilk Critical Value

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

0.679 Shapiro Wilk Test Statistic
0.788 5% Shapiro Wilk Critical Value

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean

SD

95% DL/2 (t) UCL

7989 Mean

14873 SD

17951 95% H-Stat (DL/2) UCL

2.723

4.779

1.13E+17

Maximum Likelihood Estimate(MLE) Method

MLE yields a negative mean

N/A

Log ROS Method

Mean in Log Scale

SD in Log Scale

Mean in Original Scale

2.702

4.773

7,989

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ProUCL Output – Downgradient Former Building 220 Groundwater (Excavations)
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

	SD in Original Scale	14,873
	95% Percentile Bootstrap UCL	16,713
	95% BCA Bootstrap UCL	19,601
Gamma Distribution Test with Detected Values Only	Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.18 Data do not follow a Discernable Distribution (0.05)	
Theta Star	59290	
nu star	2.156	
A-D Test Statistic	0.982 Nonparametric Statistics	
5% A-D Critical Value	0.829 Kaplan-Meier (KM) Method	
K-S Test Statistic	0.829 Mean	7,989
5% K-S Critical Value	0.367 SD	13,913
Data not Gamma Distributed at 5% Significance Level	SE of Mean	5,388
	95% KM (t) UCL	18,197
Assuming Gamma Distribution	95% KM (z) UCL	16,852
Gamma ROS Statistics using Extrapolated Data	95% KM (jackknife) UCL	17,951
Minimum	0.64 95% KM (bootstrap t) UCL	74004869
Maximum	34900 95% KM (BCA) UCL	16,713
Mean	9363 95% KM (Percentile Bootstrap) UCL	16,713
Median	2751 95% KM (Chebyshev) UCL	31,476
SD	14234 97.5% KM (Chebyshev) UCL	41,639
k star	0.193 99% KM (Chebyshev) UCL	61,601
Theta star	48607	
Nu star	3.082 Potential UCLs to Use	
AppChi2	0.397 99% KM (Chebyshev) UCL	61,601
95% Gamma Approximate UCL	72665	
95% Adjusted Gamma UCL	126094	
Warning: Recommended UCL exceeds the maximum observation		
Note: DL/2 is not a recommended method.		

trans-1,2-Dichloroethene

General Statistics

Number of Valid Data	5	Number of Detected Data	1
Number of Distinct Detected Data	1	Number of Non-Detect Data	4
		Percent Non-Detects	80.00%

Warning: Only one distinct data value was detected! ProUCL (or any other software) should not be used on such a data set!
It is suggested to use alternative site specific values determined by the Project Team to estimate environmental parameters (e.g., EPC, BTM).

The data set for variable trans-1,2-Dichloroethene was not processed!

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ProUCL Output – Downgradient Former Building 220 Groundwater (Excavations)

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Trichloroethene

General Statistics

Number of Valid Data	7	Number of Detected Data	5
Number of Distinct Detected Data	5	Number of Non-Detect Data	2
		Percent Non-Detects	28.57%

Raw Statistics

Minimum Detected
Maximum Detected
Mean of Detected
SD of Detected
Minimum Non-Detect
Maximum Non-Detect

Log-transformed Statistics

0.41 Minimum Detected
1620 Maximum Detected
812.2 Mean of Detected
769.4 SD of Detected
1 Minimum Non-Detect
5 Maximum Non-Detect

-0.892
7.39
4.015
4.357
0
1.609

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect
Number treated as Detected
Single DL Non-Detect Percentage

4
3
57.14%

Warning: There are only 5 Detected Values in this data

**Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions**

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic
5% Shapiro Wilk Critical Value

Data appear Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

0.845 Shapiro Wilk Test Statistic
0.762 5% Shapiro Wilk Critical Value

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean
SD
95% DL/2 (t) UCL

580.6 Mean

742.4 SD

1126 95% H-Stat (DL/2) UCL

2.9

4.062

1.59E+13

Maximum Likelihood Estimate(MLE) Method

MLE yields a negative mean

N/A

Log ROS Method

Mean in Log Scale
SD in Log Scale
Mean in Original Scale
SD in Original Scale
95% Percentile Bootstrap UCL
95% BCA Bootstrap UCL

2.884
4.048
580.4
742.5
1,012
1,032

APPENDIX R

ProUCL Output – Downgradient Former Building 220 Groundwater (Excavations)

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Gamma Distribution Test with Detected Values Only

k star (bias corrected)

Theta Star

nu star

Data Distribution Test with Detected Values Only

0.238 Data appear Normal at 5% Significance Level

3408

2.383

A-D Test Statistic

5% A-D Critical Value

K-S Test Statistic

5% K-S Critical Value

0.867 Nonparametric Statistics

0.753 Kaplan-Meier (KM) Method

0.753 Mean

0.383 SD

580.3

687.5

Data follow Appr. Gamma Distribution at 5% Significance Level

SE of Mean

290.5

95% KM (t) UCL

1,145

95% KM (z) UCL

1,058

95% KM (jackknife) UCL

1,126

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum

Maximum

Mean

Median

SD

k star

Theta star

Nu star

0.41

1620

753.7

607.5

636.1

0.295

2557

95% KM (bootstrap t) UCL

95% KM (BCA) UCL

95% KM (Percentile Bootstrap) UCL

95% KM (Chebyshev) UCL

97.5% KM (Chebyshev) UCL

99% KM (Chebyshev) UCL

4.127 Potential UCLs to Use

1,114

1,277

1,246

1,847

2,395

3,471

AppChi2

0.773

95% Gamma Approximate UCL

4026

95% Adjusted Gamma UCL

7197

95% KM (t) UCL

95% KM (Percentile Bootstrap) UCL

1,145

1,246

Note: DL/2 is not a recommended method.

Vinyl chloride

General Statistics

Number of Valid Observations

1 Number of Distinct Observations

1

Warning: This data set only has 1 observations!

Data set is too small to compute reliable and meaningful statistics and estimates!

The data set for variable Vinyl chloride was not processed!

It is suggested to collect at least 8 to 10 observations before using these statistical methods!

If possible, compute and collect Data Quality Objectives (DQO) based sample size and analytical results.

APPENDIX R

ProUCL Output – Downgradient Former Building 220 Groundwater (Residential)

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Summary Statistics for Raw Data Sets with NDs using Detected Data Only

				Raw Statistics using Detected Observations							
Variable	Num Ds	NumNDs	% NDs	Minimum	Maximum	Mean	Median	SD	MAD/0.675	Skewness	CV
1,2-Dichloroethane (EDC)	4	17	80.95%	3.3	189	110.6	125	80.26	65.97	-0.892	0.726
Benzene	2	19	90.48%	0.22	4	2.11	2.11	2.673	2.802	N/A	1.267
Carbon tetrachloride	2	19	90.48%	2.7	4,160	2,081	2,081	2,940	3,082	N/A	1.412
Chloroform	4	17	80.95%	0.35	790	208.5	21.9	387.8	17.38	1.996	1.86
cis-1,2-Dichloroethene	8	13	61.90%	1.5	281	85.23	28	114.9	39.14	1.241	1.348
Tetrachloroethene	9	12	57.14%	0.64	34,900	9,006	5	13,590	6.464	1.39	1.509
trans-1,2-Dichloroethene	4	17	80.95%	0.54	12	3.518	0.765	5.658	0.289	1.995	1.608
Trichloroethene	11	10	47.62%	0.41	1,620	392.5	18	632.1	26.08	1.333	1.61

APPENDIX R

ProUCL Output – Downgradient Former Building 220 Groundwater (Residential)

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

Full Precision	OFF	
Confidence Coefficient	95%	
Number of Bootstrap Operations		2,000

1,2-Dichloroethane (EDC)

General Statistics

Number of Valid Data	21	Number of Detected Data	4
Number of Distinct Detected Data	4	Number of Non-Detect Data	17
		Percent Non-Detects	80.95%

Raw Statistics

Minimum Detected
Maximum Detected
Mean of Detected
SD of Detected
Minimum Non-Detect
Maximum Non-Detect

Log-transformed Statistics

3.3 Minimum Detected 1.194
189 Maximum Detected 5.242
110.6 Mean of Detected 4.013
80.26 SD of Detected 1.898
1 Minimum Non-Detect 0
50 Maximum Non-Detect 3.912

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	18
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	3
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	85.71%

Warning: There are only 4 Distinct Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic
5% Shapiro Wilk Critical Value
Data appear Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

0.957 Shapiro Wilk Test Statistic 0.752
0.748 5% Shapiro Wilk Critical Value 0.748
Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method
Mean
SD
95% DL/2 (t) UCL

Assuming Lognormal Distribution

DL/2 Substitution Method
23.2 Mean 0.849
53.66 SD 2.003
43.4 95% H-Stat (DL/2) UCL 61.87

Maximum Likelihood Estimate(MLE) Method N/A Log ROS Method

APPENDIX R

ProUCL Output – Downgradient Former Building 220 Groundwater (Residential)
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

MLE yields a negative mean

Mean in Log Scale	-1.785
SD in Log Scale	3.807
Mean in Original Scale	21.35
SD in Original Scale	54.16
95% Percentile Bootstrap UCL	42.11
95% BCA Bootstrap UCL	51.01

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.379
Theta Star	291.6
nu star	3.033

Data Distribution Test with Detected Values Only

0.379 Data appear Normal at 5% Significance Level

A-D Test Statistic

5% A-D Critical Value

K-S Test Statistic

5% K-S Critical Value

Data appear Gamma Distributed at 5% Significance Level

0.57 Nonparametric Statistics

0.669 Kaplan-Meier (KM) Method

0.669 Mean

0.404 SD

SE of Mean

95% KM (t) UCL

95% KM (z) UCL

95% KM (jackknife) UCL

3.3 95% KM (bootstrap t) UCL

2075 95% KM (BCA) UCL

577.9 95% KM (Percentile Bootstrap) UCL

339.1 95% KM (Chebyshev) UCL

626.8 97.5% KM (Chebyshev) UCL

0.7 99% KM (Chebyshev) UCL

825.8

29.39 Potential UCLs to Use

18.02 95% KM (t) UCL

942.8 95% KM (Percentile Bootstrap) UCL

N/A

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum

Maximum

Mean

Median

SD

k star

Theta star

Nu star

AppChi2

95% Gamma Approximate UCL

95% Adjusted Gamma UCL

Note: DL/2 is not a recommended method.

Benzene

General Statistics

Number of Valid Data

Number of Distinct Detected Data

21 Number of Detected Data

2 Number of Non-Detect Data

Percent Non-Detects

2

19

90.48%

Raw Statistics

Minimum Detected

Maximum Detected

Mean of Detected

SD of Detected

Minimum Non-Detect

Log-transformed Statistics

0.22 Minimum Detected

4 Maximum Detected

2.11 Mean of Detected

2.673 SD of Detected

1 Minimum Non-Detect

-1.514

1.386

-0.0639

2.051

0

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APPENDIX R

ProUCL Output – Downgradient Former Building 220 Groundwater (Residential)

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Maximum Non-Detect	50 Maximum Non-Detect	3.912
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Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	21
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	0
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	100.00%

Warning: Data set has only 2 Distinct Detected Values.

This may not be adequate enough to compute meaningful and reliable test statistics and estimates.

The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

Unless Data Quality Objectives (DQOs) have been met, it is suggested to collect additional observations.

The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.

Those methods will return a 'N/A' value on your output display!

It is necessary to have 4 or more Distinct Values for bootstrap methods.

It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic

5% Shapiro Wilk Critical Value

Data not Normal at 5% Significance Level

N/A

Lognormal Distribution Test with Detected Values Only

1 Shapiro Wilk Test Statistic

5% Shapiro Wilk Critical Value

Data not Lognormal at 5% Significance Level

N/A

Assuming Normal Distribution

DL/2 Substitution Method

Mean

SD

95% DL/2 (t) UCL

2.844 Mean

5.529 SD

4.925 95% H-Stat (DL/2) UCL

Assuming Lognormal Distribution

DL/2 Substitution Method

0.156

1.218

4.912

Maximum Likelihood Estimate(MLE) Method

MLE method failed to converge properly

N/A

Log ROS Method

Mean in Log Scale

SD in Log Scale

Mean in Original Scale

SD in Original Scale

95% Percentile Bootstrap UCL

95% BCA Bootstrap UCL

N/A

N/A

N/A

N/A

N/A

N/A

Gamma Distribution Test with Detected Values Only

k star (bias corrected)

Theta Star

nu star

N/A

N/A

N/A

Data Distribution Test with Detected Values Only

Data do not follow a Discernable Distribution (0.05)

A-D Test Statistic

5% A-D Critical Value

K-S Test Statistic

0.356 Nonparametric Statistics

N/A

N/A

Kaplan-Meier (KM) Method

Mean

0.511

APPENDIX R

ProUCL Output – Downgradient Former Building 220 Groundwater (Residential)
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

5% K-S Critical Value	N/A	SD	1.007
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.395
		95% KM (t) UCL	1.192
Assuming Gamma Distribution		95% KM (z) UCL	1.161
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	2.967
Minimum	N/A	95% KM (bootstrap t) UCL	1.8E+308
Maximum	N/A	95% KM (BCA) UCL	4
Mean	N/A	95% KM (Percentile Bootstrap) UCL	4
Median	N/A	95% KM (Chebyshev) UCL	2.233
SD	N/A	97.5% KM (Chebyshev) UCL	2.978
k star	N/A	99% KM (Chebyshev) UCL	4.442
Theta star	N/A		
Nu star	N/A	Potential UCLs to Use	
AppChi2	N/A	99% KM (Chebyshev) UCL	4.442
95% Gamma Approximate UCL	N/A		
95% Adjusted Gamma UCL	N/A		

Warning: Recommended UCL exceeds the maximum observation

Note: DL/2 is not a recommended method.

Carbon tetrachloride

General Statistics

Number of Valid Data	21	Number of Detected Data	2
Number of Distinct Detected Data	2	Number of Non-Detect Data	19
		Percent Non-Detects	90.48%

Raw Statistics

Minimum Detected	2.7	Minimum Detected	0.993
Maximum Detected	4160	Maximum Detected	8.333
Mean of Detected	2081	Mean of Detected	4.663
SD of Detected	2940	SD of Detected	5.19
Minimum Non-Detect	1	Minimum Non-Detect	0
Maximum Non-Detect	50	Maximum Non-Detect	3.912

Log-transformed Statistics

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	20
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	1
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	95.24%

Warning: Data set has only 2 Distinct Detected Values.

This may not be adequate enough to compute meaningful and reliable test statistics and estimates.

The Project Team may decide to use alternative site specific values to estimate environmental parameters (e.g., EPC, BTV).

Unless Data Quality Objectives (DQOs) have been met, it is suggested to collect additional observations.

**The number of detected data may not be adequate enough to perform GOF tests, bootstrap, and ROS methods.
Those methods will return a 'N/A' value on your output display!**

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ProUCL Output – Downgradient Former Building 220 Groundwater (Residential)

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

It is necessary to have 4 or more Distinct Values for bootstrap methods.

It is recommended to have 10 to 15 or more observations for accurate and meaningful results and estimates.

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic

5% Shapiro Wilk Critical Value

Data not Normal at 5% Significance Level

N/A

Lognormal Distribution Test with Detected Values Only

1 Shapiro Wilk Test Statistic

1

5% Shapiro Wilk Critical Value

N/A

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean

200.9 Mean

0.606

SD

907.2 SD

2.106

95% DL/2 (t) UCL

542.3 95% H-Stat (DL/2) UCL

71.01

Maximum Likelihood Estimate(MLE) Method

N/A

MLE method failed to converge properly

Log ROS Method

Mean in Log Scale

N/A

SD in Log Scale

N/A

Mean in Original Scale

N/A

SD in Original Scale

N/A

95% Percentile Bootstrap UCL

N/A

95% BCA Bootstrap UCL

N/A

Gamma Distribution Test with Detected Values Only

k star (bias corrected)

N/A

Theta Star

N/A

nu star

N/A

Data Distribution Test with Detected Values Only

Data do not follow a Discernable Distribution (0.05)

A-D Test Statistic

0.368 Nonparametric Statistics

5% A-D Critical Value

N/A

K-S Test Statistic

N/A

5% K-S Critical Value

N/A

Data not Gamma Distributed at 5% Significance Level

SE of Mean

273.2

95% KM (t) UCL

671.9

95% KM (z) UCL

650.1

95% KM (jackknife) UCL

2,953

95% KM (bootstrap t) UCL

200.7

95% KM (BCA) UCL

N/A

95% KM (Percentile Bootstrap) UCL

4,160

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum

N/A

Maximum

N/A

Mean

N/A

Median

N/A

SD

N/A

k star

N/A

Theta star

N/A

Nu star

N/A

AppChi2

N/A

Potential UCLs to Use

99% KM (Chebyshev) UCL

2,919

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ProUCL Output – Downgradient Former Building 220 Groundwater (Residential)
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

95% Gamma Approximate UCL N/A
95% Adjusted Gamma UCL N/A

Note: DL/2 is not a recommended method.

Chloroform

General Statistics

Number of Valid Data	21	Number of Detected Data	4
Number of Distinct Detected Data	4	Number of Non-Detect Data	17
		Percent Non-Detects	80.95%

Raw Statistics

Minimum Detected	0.35	Minimum Detected	-1.05
Maximum Detected	790	Maximum Detected	6.672
Mean of Detected	208.5	Mean of Detected	2.947
SD of Detected	387.8	SD of Detected	3.157
Minimum Non-Detect	1	Minimum Non-Detect	0
Maximum Non-Detect	20	Maximum Non-Detect	2.996

Log-transformed Statistics

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	18
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	3
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	85.71%

Warning: There are only 4 Distinct Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set
the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic
5% Shapiro Wilk Critical Value
Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

0.654	Shapiro Wilk Test Statistic	0.952
0.748	5% Shapiro Wilk Critical Value	0.748
	Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution

DL/2 Substitution Method			
Mean	41.05	Mean	0.526
SD	171.7	SD	1.919
95% DL/2 (t) UCL	105.7	95% H-Stat (DL/2) UCL	26.09

Assuming Lognormal Distribution

Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE yields a negative mean		Mean in Log Scale	-0.67
		SD in Log Scale	2.927
		Mean in Original Scale	40.6
		SD in Original Scale	171.8

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ProUCL Output – Downgradient Former Building 220 Groundwater (Residential)

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

	95% Percentile Bootstrap UCL	114.9
	95% BCA Bootstrap UCL	155.8
Gamma Distribution Test with Detected Values Only	Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.239 Data appear Gamma Distributed at 5% Significance Level	
Theta Star	872.1	
nu star	1.913	
A-D Test Statistic	0.378 Nonparametric Statistics	
5% A-D Critical Value	0.707 Kaplan-Meier (KM) Method	
K-S Test Statistic	0.707 Mean	40
5% K-S Critical Value	0.419 SD	167.8
Data appear Gamma Distributed at 5% Significance Level	SE of Mean	42.29
	95% KM (t) UCL	112.9
Assuming Gamma Distribution	95% KM (z) UCL	109.6
Gamma ROS Statistics using Extrapolated Data	95% KM (jackknife) UCL	95.72
Minimum	1E-09 95% KM (bootstrap t) UCL	1335
Maximum	790 95% KM (BCA) UCL	N/A
Mean	124.3 95% KM (Percentile Bootstrap) UCL	152.8
Median	26.85 95% KM (Chebyshev) UCL	224.3
SD	190.3 97.5% KM (Chebyshev) UCL	304.1
k star	0.111 99% KM (Chebyshev) UCL	460.8
Theta star	1121	
Nu star	4.66 Potential UCLs to Use	
AppChi2	0.999 95% KM (t) UCL	112.9
95% Gamma Approximate UCL	580.3	
95% Adjusted Gamma UCL	N/A	
Note: DL/2 is not a recommended method.		

cls-1,2-Dichloroethene

General Statistics

Number of Valid Data	21	Number of Detected Data	8
Number of Distinct Detected Data	8	Number of Non-Detect Data	13
		Percent Non-Detects	61.90%

Raw Statistics

Minimum Detected	1.5	Minimum Detected	0.405
Maximum Detected	281	Maximum Detected	5.638
Mean of Detected	85.23	Mean of Detected	3.11
SD of Detected	114.9	SD of Detected	2.063
Minimum Non-Detect	1	Minimum Non-Detect	0
Maximum Non-Detect	5	Maximum Non-Detect	1.609

Log-transformed Statistics

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	15
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	6

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ProUCL Output – Downgradient Former Building 220 Groundwater (Residential)
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Observations < Largest ND are treated as NDs

Single DL Non-Detect Percentage

71.43%

Warning: There are only 8 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic

0.745 Shapiro Wilk Test Statistic

0.911

5% Shapiro Wilk Critical Value

0.818 5% Shapiro Wilk Critical Value

0.818

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean

33.16 Mean

1.062

SD

79.83 SD

2.135

95% DL/2 (t) UCL

63.2 95% H-Stat (DL/2) UCL

47.57

Assuming Lognormal Distribution

DL/2 Substitution Method

Maximum Likelihood Estimate(MLE) Method

N/A

MLE yields a negative mean

Log ROS Method

Mean in Log Scale

-0.781

SD in Log Scale

3.762

Mean in Original Scale

32.58

SD in Original Scale

80.08

95% Percentile Bootstrap UCL

61.54

95% BCA Bootstrap UCL

72.29

Gamma Distribution Test with Detected Values Only

k star (bias corrected)

0.383

Theta Star

222.8

nu star

6.121

Data Distribution Test with Detected Values Only

Data appear Gamma Distributed at 5% Significance Level

A-D Test Statistic

0.378 Nonparametric Statistics

5% A-D Critical Value

0.766 Kaplan-Meier (KM) Method

K-S Test Statistic

0.766 Mean

33.4

5% K-S Critical Value

0.31 SD

77.81

Data appear Gamma Distributed at 5% Significance Level

SE of Mean

18.15

95% KM (t) UCL

64.7

95% KM (z) UCL

63.25

95% KM (jackknife) UCL

63.31

95% KM (bootstrap t) UCL

134.5

95% KM (BCA) UCL

69.84

95% KM (Percentile Bootstrap) UCL

66.38

95% KM (Chebyshev) UCL

112.5

97.5% KM (Chebyshev) UCL

146.8

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum

1E-09

Maximum

502

Mean

123.2

Median

64.62

SD

148.7

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ProUCL Output – Downgradient Former Building 220 Groundwater (Residential)

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

k star	0.179	99% KM (Chebyshev) UCL	214
Theta star	688.4		
Nu star	7.519	Potential UCLs to Use	
AppChi2	2.46	95% KM (t) UCL	64.7
95% Gamma Approximate UCL	376.7		
95% Adjusted Gamma UCL	413.1		

Note: DL/2 is not a recommended method.

Tetrachloroethene

General Statistics

Number of Valid Data	21	Number of Detected Data	9
Number of Distinct Detected Data	9	Number of Non-Detect Data	12
		Percent Non-Detects	57.14%

Raw Statistics

Minimum Detected	0.64	Minimum Detected	-0.446
Maximum Detected	34,900	Maximum Detected	10.46
Mean of Detected	9,006	Mean of Detected	4.7
SD of Detected	13,590	SD of Detected	4.82
Minimum Non-Detect	1	Minimum Non-Detect	0
Maximum Non-Detect	5	Maximum Non-Detect	1.609

Log-transformed Statistics

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	16
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	5
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	76.19%

Warning: There are only 9 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.717	Shapiro Wilk Test Statistic	0.79
5% Shapiro Wilk Critical Value	0.829	5% Shapiro Wilk Critical Value	0.829

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Data not Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method		DL/2 Substitution Method	
Mean	3,860	Mean	2.01
SD	9,733	SD	3.918
95% DL/2 (t) UCL	7,523	95% H-Stat (DL/2) UCL	1,093,990

Maximum Likelihood Estimate(MLE) Method

N/A

Log ROS Method

MLE yields a negative mean

Mean in Log Scale

1.338

SD in Log Scale

4.662

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ProUCL Output – Downgradient Former Building 220 Groundwater (Residential)
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Mean in Original Scale	3,861
SD in Original Scale	9,732
95% Percentile Bootstrap UCL	7,551
95% BCA Bootstrap UCL	8,845

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.188
Theta Star	47,871
nu star	3.386

A-D Test Statistic

5% A-D Critical Value

K-S Test Statistic

5% K-S Critical Value

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum

Maximum

Mean

Median

SD

k star

Theta star

Nu star

AppChi2

95% Gamma Approximate UCL

95% Adjusted Gamma UCL

Note: DL/2 is not a recommended method.

Data Distribution Test with Detected Values Only

0.188 Data do not follow a Discernable Distribution (0.05)

47,871

3.386

0.938 Nonparametric Statistics

0.855 Kaplan-Meier (KM) Method

0.855 Mean

0.309 SD

SE of Mean

95% KM (t) UCL

95% KM (z) UCL

95% KM (jackknife) UCL

95% KM (bootstrap t) UCL

95% KM (BCA) UCL

95% KM (Percentile Bootstrap) UCL

95% KM (Chebyshev) UCL

97.5% KM (Chebyshev) UCL

99% KM (Chebyshev) UCL

29,599

13.91

6.506

20,943

22,265

Potential UCLs to Use

99% KM (Chebyshev) UCL

3,860

9,498

2,198

7,652

7,476

7,523

15,195

8,001

7,554

13,443

17,589

25,734

25,734

trans-1,2-Dichloroethene

General Statistics

Number of Valid Data

Number of Distinct Detected Data

21 Number of Detected Data

4 Number of Non-Detect Data

Percent Non-Detects

80.95%

Raw Statistics

Minimum Detected

Maximum Detected

Mean of Detected

SD of Detected

Minimum Non-Detect

Maximum Non-Detect

Log-transformed Statistics

0.54 Minimum Detected

12 Maximum Detected

3.518 Mean of Detected

5.658 SD of Detected

1 Minimum Non-Detect

50 Maximum Non-Detect

-0.616

2.485

0.321

1.461

0

3.912

Note: Data have multiple DLs - Use of KM Method is recommended

Number treated as Non-Detect

21

APPENDIX R

ProUCL Output – Downgradient Former Building 220 Groundwater (Residential)

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	0
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	100.00%

Warning: There are only 4 Distinct Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic

5% Shapiro Wilk Critical Value

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

0.655 Shapiro Wilk Test Statistic

0.748 5% Shapiro Wilk Critical Value

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean

SD

95% DL/2 (t) UCL

Assuming Lognormal Distribution

DL/2 Substitution Method

3.17 Mean

5.887 SD

5.386 95% H-Stat (DL/2) UCL

0.212

1.236

5.418

Maximum Likelihood Estimate(MLE) Method

MLE method failed to converge properly

N/A

Log ROS Method

Mean in Log Scale

SD in Log Scale

Mean in Original Scale

SD in Original Scale

95% Percentile Bootstrap UCL

95% BCA Bootstrap UCL

-0.177

0.964

1.483

2.517

2.514

3.14

Gamma Distribution Test with Detected Values Only

k star (bias corrected)

Theta Star

nu star

0.33

10.67

2.637

Data Distribution Test with Detected Values Only

Data appear Lognormal at 5% Significance Level

A-D Test Statistic

5% A-D Critical Value

K-S Test Statistic

5% K-S Critical Value

Data not Gamma Distributed at 5% Significance Level

0.744 **Nonparametric Statistics**

0.674 Kaplan-Meier (KM) Method

0.674 Mean

0.407 SD

SE of Mean

95% KM (t) UCL

95% KM (z) UCL

95% KM (jackknife) UCL

1E-09 95% KM (bootstrap t) UCL

12 95% KM (BCA) UCL

3.168 95% KM (Percentile Bootstrap) UCL

1.285

2.531

0.678

2.454

2.4

2.341

8.41

12

3.137

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum

Maximum

Mean

APPENDIX R

ProUCL Output – Downgradient Former Building 220 Groundwater (Residential)
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Median	3.452	95% KM (Chebyshev) UCL	4.239
SD	2.852	97.5% KM (Chebyshev) UCL	5.518
k star	0.221	99% KM (Chebyshev) UCL	8.029
Theta star	14.33		
Nu star	9.284	Potential UCLs to Use	
AppChi2	3.5	95% KM (BCA) UCL	12
95% Gamma Approximate UCL	8.405		
95% Adjusted Gamma UCL	N/A		

Note: DL/2 is not a recommended method.

Trichloroethene

General Statistics

Number of Valid Data	21	Number of Detected Data	11
Number of Distinct Detected Data	11	Number of Non-Detect Data	10
		Percent Non-Detects	47.62%

Raw Statistics

Minimum Detected	0.41
Maximum Detected	1,620
Mean of Detected	392.5
SD of Detected	632.1
Minimum Non-Detect	1
Maximum Non-Detect	5

Log-transformed Statistics

Minimum Detected	-0.892
Maximum Detected	7.39
Mean of Detected	3.494
SD of Detected	2.955
Minimum Non-Detect	0
Maximum Non-Detect	1.609

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect	12
Number treated as Detected	9
Single DL Non-Detect Percentage	57.14%

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.663
5% Shapiro Wilk Critical Value	0.85
Data not Normal at 5% Significance Level	

Lognormal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.928
5% Shapiro Wilk Critical Value	0.85
Data appear Lognormal at 5% Significance Level	

Assuming Normal Distribution

DL/2 Substitution Method

Mean	206.1	Mean	1.73
SD	489.8	SD	2.869
95% DL/2 (t) UCL	390.5	95% H-Stat (DL/2) UCL	1365

Assuming Lognormal Distribution

DL/2 Substitution Method

Maximum Likelihood Estimate(MLE) Method
MLE yields a negative mean

N/A

Log ROS Method	
Mean in Log Scale	1.242
SD in Log Scale	3.42
Mean in Original Scale	206
SD in Original Scale	489.8

APPENDIX R

ProUCL Output – Downgradient Former Building 220 Groundwater (Residential)

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

	95% Percentile Bootstrap UCL	399.6
	95% BCA Bootstrap UCL	447.2
Gamma Distribution Test with Detected Values Only	Data Distribution Test with Detected Values Only	
k star (bias corrected)	0.265 Data appear Gamma Distributed at 5% Significance Level	
Theta Star	1,480	
nu star	5.833	
A-D Test Statistic	0.576 Nonparametric Statistics	
5% A-D Critical Value	0.828 Kaplan-Meier (KM) Method	
K-S Test Statistic	0.828 Mean	205.8
5% K-S Critical Value	0.277 SD	478.1
Data appear Gamma Distributed at 5% Significance Level	SE of Mean	109.4
	95% KM (t) UCL	394.6
Assuming Gamma Distribution	95% KM (z) UCL	385.8
Gamma ROS Statistics using Extrapolated Data	95% KM (jackknife) UCL	390.2
Minimum	0.41 95% KM (bootstrap t) UCL	521.1
Maximum	1620 95% KM (BCA) UCL	399.25
Mean	399.5 95% KM (Percentile Bootstrap) UCL	396.1
Median	311.8 95% KM (Chebyshev) UCL	682.8
SD	454.5 97.5% KM (Chebyshev) UCL	889.2
k star	0.448 99% KM (Chebyshev) UCL	1295
Theta star	892.5	
Nu star	18.8 Potential UCLs to Use	
AppChi2	9.973 95% KM (BCA) UCL	399.25
95% Gamma Approximate UCL	753.3	
95% Adjusted Gamma UCL	792.4	

Note: DL/2 Is not a recommended method.

APPENDIX R

ProUCL Output – Off-Site Groundwater

*St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri***Summary Statistics for Raw Data Sets with NDs using Detected Data Only**

				Raw Statistics using Detected Observations							
Variable	Num Ds	NumNDs	% NDs	Minimum	Maximum	Mean	Median	SD	MAD/0.675	Skewness	CV
1,2-Dichloroethane (EDC)	3	9	75.00%	3	150	84.33333	100	74.74178	74.128984	-0.901804	0.886266
cis-1,2-Dichloroethene	6	6	50.00%	1.5	82.2	25.13333	9.7	32.48456	12.008895	1.4134023	1.292489
Tetrachloroethene	4	8	66.67%	2.9	9,440	4,286.70	3,851.95	4,996.68	5,705.78	0.1039518	1.165624
Trichloroethene	6	6	50.00%	5.1	129	42.78333	17.4	51.08504	17.716827	1.269906	1.194041

APPENDIX R

ProUCL Output – Off-Site Groundwater

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

General UCL Statistics for Data Sets with Non-Detects

User Selected Options

Full Precision	ON	
Confidence Coefficient	95%	
Number of Bootstrap Operations		2,000

1,2-Dichloroethane (EDC)

General Statistics

Number of Valid Samples	12	Number of Detected Data	3
Number of Unique Samples	3	Number of Non-Detect Data	9
		Percent Non-Detects	75.00%

Raw Statistics

Minimum Detected	3	Minimum Detected	1.0986123
Maximum Detected	150	Maximum Detected	5.0106353
Mean of Detected	84.33333	Mean of Detected	3.5714726
SD of Detected	74.74178	SD of Detected	2.1511344
Minimum Non-Detect	1	Minimum Non-Detect	0
Maximum Non-Detect	5	Maximum Non-Detect	1.6094379

Log-transformed Statistics

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	10
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	2
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	83.33%

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.967029	Shapiro Wilk Test Statistic	0.826798
5% Shapiro Wilk Critical Value	0.767	5% Shapiro Wilk Critical Value	0.767
Data appear Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Lognormal Distribution Test with Detected Values Only

Assuming Normal Distribution

DL/2 Substitution Method		DL/2 Substitution Method	
Mean	21.79167	Mean	0.6412474
SD	49.3823	SD	2.0808429
95% DL/2 (t) UCL	47.3928	95% H-Stat (DL/2) UCL	96.789965

Assuming Lognormal Distribution

Maximum Likelihood Estimate(MLE) Method	N/A	Log ROS Method	
MLE method failed to converge properly		Mean in Log Scale	-2.151452
		SD in Log Scale	4.2401613
		Mean in Original Scale	21.170981
		SD in Original Scale	49.663307
		95% Percentile Bootstrap UCL	46.102266
		95% BCA Bootstrap UCL	54.265212

APPENDIX R

ProUCL Output – Off-Site Groundwater

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	N/A
Theta Star	N/A
nu star	N/A

Data Distribution Test with Detected Values Only**Data appear Normal at 5% Significance Level**

A-D Test Statistic	0.45289
5% A-D Critical Value	N/A
K-S Test Statistic	N/A
5% K-S Critical Value	N/A

Data not Gamma Distributed at 5% Significance Level**Assuming Gamma Distribution**

Gamma ROS Statistics using Extrapolated Data

Minimum	N/A
Maximum	N/A
Mean	N/A
Median	N/A
SD	N/A
k star	N/A
Theta star	N/A
Nu star	N/A
AppChi2	N/A
95% Gamma Approximate UCL	N/A
95% Adjusted Gamma UCL	N/A

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean	23.333333
SD	46.598164
SE of Mean	16.474939
95% KM (t) UCL	52.920425
95% KM (z) UCL	50.432196
95% KM (jackknife) UCL	86.868578
95% KM (bootstrap t) UCL	33.16672
95% KM (BCA) UCL	N/A
95% KM (Percentile Bootstrap) UCL	150
95% KM (Chebyshev) UCL	95.145927
97.5% KM (Chebyshev) UCL	126.21929
99% KM (Chebyshev) UCL	187.25691

Potential UCLs to Use

95% KM (t) UCL	52.920425
95% KM (Percentile Bootstrap) UCL	150

Note: DL/2 is not a recommended method.**cis-1,2-Dichloroethene****General Statistics**

Number of Valid Samples	12	Number of Detected Data	6
Number of Unique Samples	6	Number of Non-Detect Data	6
		Percent Non-Detects	50.00%

Raw Statistics

Minimum Detected	1.5
Maximum Detected	82.2
Mean of Detected	25.13333
SD of Detected	32.48456
Minimum Non-Detect	1
Maximum Non-Detect	5

Log-transformed Statistics

Minimum Detected	0.4054651
Maximum Detected	4.4091553
Mean of Detected	2.2861975
SD of Detected	1.64363
Minimum Non-Detect	0
Maximum Non-Detect	1.6094379

Note: Data have multiple DLs - Use of KM Method is recommended
 For all methods (except KM, DL/2, and ROS Methods),
 Observations < Largest ND are treated as NDs

Number treated as Non-Detect	8
Number treated as Detected	4
Single DL Non-Detect Percentage	66.67%

APPENDIX R

ProUCL Output – Off-Site Groundwater

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic

5% Shapiro Wilk Critical Value

Data not Normal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean

SD

95% DL/2 (t) UCL

Maximum Likelihood Estimate(MLE) Method

MLE yields a negative mean

Lognormal Distribution Test with Detected Values Only

0.785588 Shapiro Wilk Test Statistic

0.788 5% Shapiro Wilk Critical Value

Data appear Lognormal at 5% Significance Level

Assuming Lognormal Distribution

DL/2 Substitution Method

12.98333 Mean

25.31804 SD

26.1089 95% H-Stat (DL/2) UCL

N/A Log ROS Method

Mean in Log Scale

SD in Log Scale

Mean in Original Scale

SD in Original Scale

95% Percentile Bootstrap UCL

95% BCA Bootstrap UCL

0.9098064

0.788

0.930645

1.8516932

34.510195

0.0520671

2.7297607

12.661143

25.482678

25.467754

29.989225

Gamma Distribution Test with Detected Values Only

k star (bias corrected)

Theta Star

nu star

0.436587

57.56782

5.239038

Data Distribution Test with Detected Values Only

Data appear Gamma Distributed at 5% Significance Level

A-D Test Statistic

5% A-D Critical Value

K-S Test Statistic

5% K-S Critical Value

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum

Maximum

Mean

Median

SD

k star

Theta star

Nu star

AppChi2

95% Gamma Approximate UCL

95% Adjusted Gamma UCL

0.374701

0.726878

0.726878

0.345494

Nonparametric Statistics

Kaplan-Meier (KM) Method

Mean

SD

SE of Mean

95% KM (t) UCL

95% KM (z) UCL

95% KM (jackknife) UCL

95% KM (bootstrap t) UCL

95% KM (BCA) UCL

95% KM (Percentile Bootstrap) UCL

95% KM (Chebyshev) UCL

97.5% KM (Chebyshev) UCL

99% KM (Chebyshev) UCL

Potential UCLs to Use

95% KM (t) UCL

13.319048

24.067902

7.6109421

26.987422

25.837933

26.281115

79.502498

29.766667

27.733333

46.494375

60.849366

89.046965

26.987422

Note: DL/2 is not a recommended method.

APPENDIX R**ProUCL Output – Off-Site Groundwater***St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri***Tetrachloroethene****General Statistics**

Number of Valid Samples	12	Number of Detected Data	4
Number of Unique Samples	4	Number of Non-Detect Data	8
		Percent Non-Detects	66.67%

Raw Statistics

Minimum Detected
Maximum Detected
Mean of Detected
SD of Detected
Minimum Non-Detect
Maximum Non-Detect

Log-transformed Statistics

2.9 Minimum Detected 1.0647107
9440 Maximum Detected 9.1527113
4,286.70 Mean of Detected 5.1318435
4,996.68 SD of Detected 4.5276514
1 Minimum Non-Detect 0
5 Maximum Non-Detect 1.6094379

Note: Data have multiple DLs - Use of KM Method is recommended
For all methods (except KM, DL/2, and ROS Methods),
Observations < Largest ND are treated as NDs

Number treated as Non-Detect 10
Number treated as Detected 2
Single DL Non-Detect Percentage 83.33%

UCL Statistics**Normal Distribution Test with Detected Values Only**

Shapiro Wilk Test Statistic
5% Shapiro Wilk Critical Value

Lognormal Distribution Test with Detected Values Only

0.807248 Shapiro Wilk Test Statistic 0.7586616
0.748 5% Shapiro Wilk Critical Value 0.748

Data appear Normal at 5% Significance Level**Data appear Lognormal at 5% Significance Level****Assuming Normal Distribution**

DL/2 Substitution Method

Mean

1,429.58

SD

3,355.85

95% DL/2 (t) UCL

3,169.35

Assuming Lognormal Distribution

DL/2 Substitution Method

Mean

1.5405836

SD

3.5999261

95% H-Stat (DL/2) UCL

2,171,767.90

Maximum Likelihood Estimate(MLE) Method

N/A

Log ROS Method

MLE method failed to converge properly

Mean in Log Scale

-3.362231

SD in Log Scale

7.3315961

Mean in Original Scale

1,428.91

SD in Original Scale

3,356.16

95% Percentile Bootstrap UCL

3,002.00

95% BCA Bootstrap UCL

3,498.66

Gamma Distribution Test with Detected Values Only

k star (bias corrected)

0.222604

Theta Star

19,257.09

nu star

1.78083

Data Distribution Test with Detected Values Only**Data appear Normal at 5% Significance Level**

A-D Test Statistic

0.672477 **Nonparametric Statistics**

APPENDIX R

ProUCL Output – Off-Site Groundwater

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

5% A-D Critical Value	0.725778	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.725778	Mean	1,430.85
5% K-S Critical Value	0.422889	SD	3,212.42
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	1,070.81
		95% KM (t) UCL	3,353.90
Assuming Gamma Distribution		95% KM (z) UCL	3,192.17
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	3,169.83
Minimum	2.9	95% KM (bootstrap t) UCL	7,755,253.80
Maximum	11,704.67	95% KM (BCA) UCL	N/A
Mean	5,030.08	95% KM (Percentile Bootstrap) UCL	7990
Median	3,756.74	95% KM (Chebyshev) UCL	6,098.39
SD	3,607.31	97.5% KM (Chebyshev) UCL	8,118.04
k star	0.461279	99% KM (Chebyshev) UCL	12,085.24
Theta star	10,904.64		
Nu star	11.0707	Potential UCLs to Use	
AppChi2	4.621504	95% KM (t) UCL	3,353.90
95% Gamma Approximate UCL	12,049.44	95% KM (Percentile Bootstrap) UCL	7,990
95% Adjusted Gamma UCL		N/A	

Note: DL/2 is not a recommended method.

Trichloroethene

General Statistics

Number of Valid Samples	12	Number of Detected Data	6
Number of Unique Samples	6	Number of Non-Detect Data	6
		Percent Non-Detects	50.00%

Raw Statistics

Minimum Detected	5.1	Minimum Detected	1.6292405
Maximum Detected	129	Maximum Detected	4.8598124
Mean of Detected	42.78333	Mean of Detected	3.0608968
SD of Detected	51.08504	SD of Detected	1.3327665
Minimum Non-Detect	1	Minimum Non-Detect	0
Maximum Non-Detect	5	Maximum Non-Detect	1.6094379

Log-transformed Statistics

Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect	6
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected	6
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	50.00%

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.784366	Shapiro Wilk Test Statistic	0.8997857
5% Shapiro Wilk Critical Value	0.788	5% Shapiro Wilk Critical Value	0.788

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

Assuming Lognormal Distribution

APPENDIX R

ProUCL Output – Off-Site Groundwater

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

DL/2 Substitution Method

Mean	21.80833	DL/2 Substitution Method	Mean	1.3179946
SD	40.8224		SD	2.0778574
95% DL/2 (t) UCL	42.97178	95% H-Stat (DL/2) UCL		106.19625

Maximum Likelihood Estimate(MLE) Method

MLE yields a negative mean

N/A

Log ROS Method

Mean in Log Scale	1.0570936
SD in Log Scale	2.4013271
Mean in Original Scale	21.691424
SD in Original Scale	40.886054
95% Percentile Bootstrap UCL	42.602783
95% BCA Bootstrap UCL	48.202214

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	0.534756
Theta Star	80.00534
nu star	6.417072

Data Distribution Test with Detected Values Only

Data appear Gamma Distributed at 5% Significance Level

A-D Test Statistic

5% A-D Critical Value

K-S Test Statistic

5% K-S Critical Value

0.461028 **Nonparametric Statistics**

0.718698 Kaplan-Meier (KM) Method

0.718698 Mean 23.941667 |

0.342438 SD 37.978622 |

Data appear Gamma Distributed at 5% Significance Level

SE of Mean 12.009895 |

95% KM (t) UCL 45.510054 |

95% KM (z) UCL 43.696186 |

95% KM (jackknife) UCL 44.259685 |

95% KM (bootstrap t) UCL 139.025 |

95% KM (BCA) UCL 51.233333 |

95% KM (Percentile Bootstrap) UCL 46.566667 |

95% KM (Chebyshev) UCL 76.291585 |

97.5% KM (Chebyshev) UCL 98.943437 |

99% KM (Chebyshev) UCL 143.43861 |

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum 5.1 |

Maximum 129 |

Mean 42.78333 |

Median 32.53078 |

SD 37.47199 |

k star 1.090063 |

Theta star 39.24849 |

Nu star 26.16152 |

AppChi2 15.50377 |

95% Gamma Approximate UCL 72.19383 |

95% Adjusted Gamma UCL 78.46771 |

Potential UCLs to Use

95% KM (t) UCL 45.510054 |

Note: DL/2 is not a recommended method.

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APPENDIX R

ProUCL Output – On-Site Groundwater (Excluding Area Downgradient of Former Building 220)

*St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri***Summary Statistics for Raw Dataset with NDs**

				Raw Statistics using Detected Observations							
Variable	Num Ds	NumNDs	% NDs	Minimum	Maximum	Mean	Median	SD	MAD/0.675	Skewness	CV
1,2-Dichloroethane (EDC)	3	2	40.00%	3.3	189	65.56667	4.4	106.8978	1.6308377	1.7318445	1.630368

APPENDIX R

ProUCL Output – On-Site Groundwater (Excluding Area Downgradient of Former Building 220)
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

General UCL Statistics for Data Sets with Non-Detects**User Selected Options**

Full Precision ON
Confidence Coefficient 95%
Number of Bootstrap Operations

2,000

1,2-Dichloroethane (EDC)**General Statistics**

Number of Valid Samples	5 Number of Detected Data	3
Number of Unique Samples	3 Number of Non-Detect Data	2
	Percent Non-Detects	40.00%

Raw Statistics

Minimum Detected	3.3 Minimum Detected	1.1939225
Maximum Detected	189 Maximum Detected	5.241747
Mean of Detected	65.56667 Mean of Detected	2.6390913
SD of Detected	106.8978 SD of Detected	2.258551
Minimum Non-Detect	1 Minimum Non-Detect	0
Maximum Non-Detect	1 Maximum Non-Detect	0

Log-transformed Statistics**UCL Statistics****Normal Distribution Test with Detected Values Only**

Shapiro Wilk Test Statistic
5% Shapiro Wilk Critical Value

Lognormal Distribution Test with Detected Values Only

0.754428 Shapiro Wilk Test Statistic
0.767 5% Shapiro Wilk Critical Value

Data not Normal at 5% Significance Level**Data appear Lognormal at 5% Significance Level****Assuming Normal Distribution****DL/2 Substitution Method**

Mean
SD
95% DL/2 (t) UCL

Assuming Lognormal Distribution**DL/2 Substitution Method**

39.54 Mean	1.3061959
83.56837 SD	2.4252155
119.2133 95% H-Stat (DL/2) UCL	390,826.63

Maximum Likelihood Estimate(MLE) Method

Mean
SD
95% MLE (t) UCL
95% MLE (Tiku) UCL

Log ROS Method

6.373299 Mean in Log Scale	0.0217896
106.958 SD in Log Scale	4.0023119
108.346 Mean in Original Scale	39.353637
120.8927 SD in Original Scale	83.677521
95% Percentile Bootstrap UCL	114.06132
95% BCA Bootstrap UCL	114.94

Gamma Distribution Test with Detected Values Only

k star (bias corrected)
Theta Star
nu star

N/A
N/A
N/A

Data Distribution Test with Detected Values Only**Data appear Lognormal at 5% Significance Level**

APPENDIX R

ProUCL Output – On-Site Groundwater (Excluding Area Downgradient of Former Building 220)

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

A-D Test Statistic	0.54795	Nonparametric Statistics	
5% A-D Critical Value	N/A	Kaplan-Meier (KM) Method	
K-S Test Statistic	N/A	Mean	40.66
5% K-S Critical Value	N/A	SD	74.171224
Data not Gamma Distributed at 5% Significance Level		SE of Mean	40.625252
		95% KM (t) UCL	127.26678
		95% KM (z) UCL	107.48259
Assuming Gamma Distribution		95% KM (jackknife) UCL	119.52224
Gamma ROS Statistics using Extrapolated Data		95% KM (bootstrap t) UCL	6681.1622
Minimum	N/A	95% KM (BCA) UCL	189
Maximum	N/A	95% KM (Percentile Bootstrap) UCL	189
Mean	N/A	95% KM (Chebyshev) UCL	217.74137
Median	N/A	97.5% KM (Chebyshev) UCL	294.36462
SD	N/A	99% KM (Chebyshev) UCL	444.87616
k star	N/A		
Theta star	N/A		
Nu star	N/A	Potential UCLs to Use	
AppChi2	N/A	99% KM (Chebyshev) UCL	444.87616
95% Gamma Approximate UCL	N/A		
95% Adjusted Gamma UCL	N/A		

Warning: Recommended UCL exceeds the maximum observation.**Note: DL/2 is not a recommended method.**

APPENDIX R

ProUCL Output – Sitewide Soil (0-2 ft bgs)

*St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri***Summary Statistics for Raw Data Sets with NDs using Detected Data Only**

				Raw Statistics using Detected Observations							
Variable	Num Ds	NumNDs	% NDs	Minimum	Maximum	Mean	Median	SD	MAD/0.675	Skewness	CV
Arsenic (mg/kg)	75	3	3.85%	4	36.3	9.498	8.11	4.989	2.829	2.659	0.525
Benzo(a)pyrene (mg/kg)	17	0	0.00%	0.0472	0.505	0.188	0.143	0.15	0.0958	1.263	0.797
Lead (mg/kg)	99	0	0.00%	11.9	1416	137.8	65.9	232.9	55.68	3.697	1.69
Tetrachloroethene (mg/kg)	9	0	0.00%	0.0012	6.4	0.777	0.052	2.111	0.0753	2.99	2.717
Trichloroethene (mg/kg)	6	3	33.33%	0.0011	0.81	0.238	0.0115	0.365	0.0146	1.122	1.535

APPENDIX R

ProUCL Output – Sitewide Soil (0-2 ft bgs)

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

General UCL Statistics for Data Sets with Non-Detects**User Selected Options**

Full Precision	OFF	
Confidence Coefficient	95%	
Number of Bootstrap Operations		2,000

Arsenic (mg/kg)**General Statistics**

Number of Valid Data	78	Number of Detected Data	75
Number of Distinct Detected Data	67	Number of Non-Detect Data	3
Number of Missing Values	46	Percent Non-Detects	3.85%

Raw Statistics

Minimum Detected
Maximum Detected
Mean of Detected
SD of Detected
Minimum Non-Detect
Maximum Non-Detect

Log-transformed Statistics

4. Minimum Detected	1.386
36.3 Maximum Detected	3.592
9.498 Mean of Detected	2.154
4.989 SD of Detected	0.419
0.25 Minimum Non-Detect	-1.386
0.25 Maximum Non-Detect	-1.386

UCL Statistics**Normal Distribution Test with Detected Values Only**

Lilliefors Test Statistic
5% Lilliefors Critical Value

Data not Normal at 5% Significance Level**Lognormal Distribution Test with Detected Values Only**

0.173 Lilliefors Test Statistic	0.0933
0.102 5% Lilliefors Critical Value	0.102

Data appear Lognormal at 5% Significance Level**Assuming Normal Distribution**

DL/2 Substitution Method

Mean

SD

95% DL/2 (t) UCL

Assuming Lognormal Distribution

DL/2 Substitution Method

9.138 Mean	1.991
5.217 SD	0.917
10.12 95% H-Stat (DL/2) UCL	11.92

Maximum Likelihood Estimate(MLE) Method

Mean

SD

95% MLE (t) UCL

95% MLE (Tiku) UCL

Log ROS Method

9.057 Mean in Log Scale	2.115
5.352 SD in Log Scale	0.456
10.07 Mean in Original Scale	9.253
10.06 SD in Original Scale	5.044
95% Percentile Bootstrap UCL	10.24
95% BCA Bootstrap UCL	10.42

Gamma Distribution Test with Detected Values Only

k star (bias corrected)

Theta Star

nu star

Data Distribution Test with Detected Values Only

5.106 Data appear Lognormal at 5% Significance Level

1.86

765.9

APPENDIX R

ProUCL Output – Sitewide Soil (0-2 ft bgs)

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

A-D Test Statistic	1.584	Nonparametric Statistics	
5% A-D Critical Value	0.754	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.754	Mean	9.287
5% K-S Critical Value	0.103	SD	4.973
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.567
		95% KM (t) UCL	10.23
		95% KM (z) UCL	10.22
		95% KM (jackknife) UCL	10.22
Assuming Gamma Distribution		95% KM (bootstrap t) UCL	10.49
Gamma ROS Statistics using Extrapolated Data	1E-09	95% KM (BCA) UCL	10.33
Minimum	36.3	95% KM (Percentile Bootstrap) UCL	10.35
Maximum	9.149	95% KM (Chebyshev) UCL	11.76
Mean	8.07	97.5% KM (Chebyshev) UCL	12.83
Median	5.198	99% KM (Chebyshev) UCL	14.93
SD	1.267		
k star	7.223		
Theta star	197.6	Potential UCLs to Use	
Nu star	166.1	95% KM (BCA) UCL	10.33
AppChi2	10.89		
95% Gamma Approximate UCL	10.92		
95% Adjusted Gamma UCL			

Note: DL/2 is not a recommended method.

Benzo(a)pyrene (mg/kg)

General Statistics

Number of Valid Data	17	Number of Detected Data	17
Number of Distinct Detected Data	17	Number of Non-Detect Data	0
Number of Missing Values	36	Percent Non-Detects	0.00%

Raw Statistics

Minimum Detected	0.0472	Minimum Detected	-3.053
Maximum Detected	0.505	Maximum Detected	-0.683
Mean of Detected	0.188	Mean of Detected	-1.939
SD of Detected	0.15	SD of Detected	0.741
Minimum Non-Detect	N/A	Minimum Non-Detect	N/A
Maximum Non-Detect	N/A	Maximum Non-Detect	N/A

Log-transformed Statistics

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic	0.802	Shapiro Wilk Test Statistic	0.939
5% Shapiro Wilk Critical Value	0.892	5% Shapiro Wilk Critical Value	0.892

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

Data appear Lognormal at 5% Significance Level

APPENDIX R

ProUCL Output – Sitewide Soil (0-2 ft bgs)

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Assuming Normal Distribution

DL/2 Substitution Method

Mean

0.188 Mean

-1.939

SD

0.15 SD

0.741

95% DL/2 (t) UCL

0.252 95% H-Stat (DL/2) UCL

0.29

Maximum Likelihood Estimate(MLE) Method

N/A

MLE method failed to converge properly**Assuming Lognormal Distribution**

DL/2 Substitution Method

Log ROS Method

Mean in Log Scale

N/A

SD in Log Scale

N/A

Mean in Original Scale

N/A

SD in Original Scale

N/A

95% Percentile Bootstrap UCL

N/A

95% BCA Bootstrap UCL

N/A

Gamma Distribution Test with Detected Values Only

k star (bias corrected)

1.699

Theta Star

0.111

nu star

57.77

Data Distribution Test with Detected Values Only

1.699 Data appear Gamma Distributed at 5% Significance Level

A-D Test Statistic

0.651 Nonparametric Statistics

5% A-D Critical Value

0.749 Kaplan-Meier (KM) Method

K-S Test Statistic

0.749 Mean

0.188

5% K-S Critical Value

0.212 SD

0.146

Data appear Gamma Distributed at 5% Significance Level

SE of Mean

0.0364

95% KM (t) UCL

0.252

95% KM (z) UCL

0.248

95% KM (jackknife) UCL

0.252

0.0472 95% KM (bootstrap t) UCL

0.275

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum

0.505

Maximum

0.188

Mean

95% KM (BCA) UCL

0.25

Median

95% KM (Percentile Bootstrap) UCL

0.249

SD

0.143 95% KM (Chebyshev) UCL

0.347

k star

0.15 97.5% KM (Chebyshev) UCL

0.415

Theta star

1.699 99% KM (Chebyshev) UCL

0.55

Nu star

0.111

AppChi2

57.77 Potential UCLs to Use

95% Gamma Approximate UCL

41.3

95% KM (Chebyshev) UCL

0.347

95% Adjusted Gamma UCL

0.263

0.273

Note: DL/2 is not a recommended method.**Lead (mg/kg)****General Statistics**

Number of Valid Data

99 Number of Detected Data

99

Number of Distinct Detected Data

97 Number of Non-Detect Data

0

Number of Missing Values

25 Percent Non-Detects

0.00%

APPENDIX R

ProUCL Output – Sitewide Soil (0-2 ft bgs)

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Raw Statistics

Minimum Detected
Maximum Detected
Mean of Detected
SD of Detected
Minimum Non-Detect
Maximum Non-Detect

Log-transformed Statistics

11.9	Minimum Detected	2.477
1416	Maximum Detected	7.256
137.8	Mean of Detected	4.268
232.9	SD of Detected	1.03
N/A	Minimum Non-Detect	N/A
N/A	Maximum Non-Detect	N/A

UCL Statistics

Normal Distribution Test with Detected Values Only

Lilliefors Test Statistic
5% Lilliefors Critical Value
Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

0.302	Lilliefors Test Statistic	0.0792
0.089	5% Lilliefors Critical Value	0.089
Data appear Lognormal at 5% Significance Level		

Assuming Normal Distribution

DL/2 Substitution Method
Mean
SD
95% DL/2 (t) UCL

Assuming Lognormal Distribution

	DL/2 Substitution Method	
137.8	Mean	4.268
232.9	SD	1.03
176.7	95% H-Stat (DL/2) UCL	153.2

Maximum Likelihood Estimate(MLE) Method
MLE method failed to converge properly

N/A	Log ROS Method	
	Mean in Log Scale	N/A
	SD in Log Scale	N/A
	Mean in Original Scale	N/A
	SD in Original Scale	N/A
	95% Percentile Bootstrap UCL	N/A
	95% BCA Bootstrap UCL	N/A

Gamma Distribution Test with Detected Values Only

k star (bias corrected)
Theta Star
nu star

Data Distribution Test with Detected Values Only

0.87	Data appear Lognormal at 5% Significance Level
158.4	
172.2	

A-D Test Statistic
5% A-D Critical Value
K-S Test Statistic
5% K-S Critical Value

5.086	Nonparametric Statistics	
0.788	Kaplan-Meier (KM) Method	
0.788	Mean	137.8
0.093	SD	231.7
	SE of Mean	23.41

Data not Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data
Minimum
Maximum
Mean
Median
SD

	95% KM (t) UCL	176.7
	95% KM (z) UCL	176.3
	95% KM (jackknife) UCL	176.7
11.9	95% KM (bootstrap t) UCL	194.8
1416	95% KM (BCA) UCL	179
137.8	95% KM (Percentile Bootstrap) UCL	176.8
65.9	95% KM (Chebyshev) UCL	239.8
232.9	97.5% KM (Chebyshev) UCL	284

APPENDIX R

ProUCL Output – Sitewide Soil (0-2 ft bgs)

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

k star	0.87	99% KM (Chebyshev) UCL	370.7
Theta star	158.4		
Nu star	172.2	Potential UCLs to Use	
AppChi2	142.9	95% KM (Chebyshev) UCL	239.8
95% Gamma Approximate UCL	166.1		
95% Adjusted Gamma UCL	166.6		

Note: DL/2 is not a recommended method.

Tetrachloroethene (mg/kg)

General Statistics

Number of Valid Data	9	Number of Detected Data	9
Number of Distinct Detected Data	8	Number of Non-Detect Data	0
Number of Missing Values	53	Percent Non-Detects	0.00%

Raw Statistics

Minimum Detected	0.0012	Minimum Detected	-6.725
Maximum Detected	6.4	Maximum Detected	1.856
Mean of Detected	0.777	Mean of Detected	-3.195
SD of Detected	2.111	SD of Detected	2.712
Minimum Non-Detect	N/A	Minimum Non-Detect	N/A
Maximum Non-Detect	N/A	Maximum Non-Detect	N/A

Log-transformed Statistics

Warning: There are only 9 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic
5% Shapiro Wilk Critical Value
Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

0.425 Shapiro Wilk Test Statistic
0.829 5% Shapiro Wilk Critical Value
Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method
Mean
SD
95% DL/2 (t) UCL

0.777 Mean
2.111 SD
2.085 95% H-Stat (DL/2) UCL

Assuming Lognormal Distribution

DL/2 Substitution Method
Mean
SD
2.712
2323

Maximum Likelihood Estimate(MLE) Method
MLE method failed to converge properly

N/A Log ROS Method
Mean in Log Scale
SD in Log Scale
N/A
N/A

APPENDIX R

ProUCL Output – Sitewide Soil (0-2 ft bgs)

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Mean in Original Scale	N/A
SD in Original Scale	N/A
95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A

Gamma Distribution Test with Detected Values Only

k star (bias corrected)

Theta Star

nu star

Data Distribution Test with Detected Values Only

0.236 Data Follow Appr. Gamma Distribution at 5% Significance Level

3.295

4.244

A-D Test Statistic

5% A-D Critical Value

K-S Test Statistic

5% K-S Critical Value

0.85 Nonparametric Statistics

0.829 Kaplan-Meier (KM) Method

0.829 Mean

0.305 SD

0.777

1.99

Data follow Appr. Gamma Distribution at 5% Significance Level

SE of Mean

0.704

95% KM (t) UCL

2.085

95% KM (z) UCL

1.934

95% KM (jackknife) UCL

2.085

0.0012 95% KM (bootstrap t) UCL

31.97

6.4 95% KM (BCA) UCL

2.191

0.777 95% KM (Percentile Bootstrap) UCL

2.163

0.052 95% KM (Chebyshev) UCL

3.844

2.111 97.5% KM (Chebyshev) UCL

5.17

0.236 99% KM (Chebyshev) UCL

7.777

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum

Maximum

Mean

Median

SD

k star

Theta star

Nu star

AppChi2

4.244 Potential UCLs to Use

0.821 95% KM (Chebyshev) UCL

3.844

95% Gamma Approximate UCL

4.019

95% Adjusted Gamma UCL

5.934

Note: DL/2 is not a recommended method.

Trichloroethene (mg/kg)

General Statistics

Number of Valid Data

Number of Distinct Detected Data

Number of Missing Values

9 Number of Detected Data

6 Number of Non-Detect Data

53 Percent Non-Detects

6

3

33.33%

Raw Statistics

Minimum Detected

Maximum Detected

Mean of Detected

SD of Detected

Minimum Non-Detect

Maximum Non-Detect

Log-transformed Statistics

0.0011 Minimum Detected

0.81 Maximum Detected

0.238 Mean of Detected

0.365 SD of Detected

0.006 Minimum Non-Detect

0.0065 Maximum Non-Detect

-6.812

-0.211

-3.795

2.811

-5.116

-5.036

APPENDIX R

ProUCL Output – Sitewide Soil (0-2 ft bgs)

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	5
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	4
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	55.56%

Warning: There are only 6 Detected Values in this data

Note: It should be noted that even though bootstrap may be performed on this data set the resulting calculations may not be reliable enough to draw conclusions

It is recommended to have 10-15 or more distinct observations for accurate and meaningful results.

UCL Statistics

Normal Distribution Test with Detected Values Only

Shapiro Wilk Test Statistic

5% Shapiro Wilk Critical Value

Data not Normal at 5% Significance Level

Lognormal Distribution Test with Detected Values Only

0.707 Shapiro Wilk Test Statistic 0.877

0.788 5% Shapiro Wilk Critical Value 0.788

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

DL/2 Substitution Method

Mean

SD

95% DL/2 (t) UCL

Assuming Lognormal Distribution

DL/2 Substitution Method

0.16 Mean -4.454

0.311 SD 2.432

0.353 95% H-Stat (DL/2) UCL 105.9

Maximum Likelihood Estimate(MLE) Method

MLE yields a negative mean

N/A

Log ROS Method

Mean in Log Scale -4.763

SD in Log Scale 2.655

Mean in Original Scale 0.159

SD in Original Scale 0.312

95% Percentile Bootstrap UCL 0.338

95% BCA Bootstrap UCL 0.378

Gamma Distribution Test with Detected Values Only

k star (bias corrected)

Theta Star

nu star

0.258 **Data appear Gamma Distributed at 5% Significance Level**

0.922

3.094

Data Distribution Test with Detected Values Only

A-D Test Statistic

5% A-D Critical Value

K-S Test Statistic

5% K-S Critical Value

0.617 **Nonparametric Statistics**

0.769 Kaplan-Meier (KM) Method

0.769 Mean 0.159

0.357 SD 0.294

APPENDIX R

ProUCL Output – Sitewide Soil (0-2 ft bgs)

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Data appear Gamma Distributed at 5% Significance Level		SE of Mean	0.107
		95% KM (t) UCL	0.359
Assuming Gamma Distribution		95% KM (z) UCL	0.335
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.352
Minimum	0.0011	95% KM (bootstrap t) UCL	9.341
Maximum	0.81	95% KM (BCA) UCL	0.378
Mean	0.198	95% KM (Percentile Bootstrap) UCL	0.337
Median	0.119	95% KM (Chebyshev) UCL	0.627
SD	0.294	97.5% KM (Chebyshev) UCL	0.829
k star	0.344	99% KM (Chebyshev) UCL	1.226
Theta star	0.575		
Nu star	6.195	Potential UCLs to Use	
AppChi2	1.74	95% KM (BCA) UCL	0.378
95% Gamma Approximate UCL	0.705		
95% Adjusted Gamma UCL	0.951		

Note: DL/2 is not a recommended method.

APPENDIX R

ProUCL Output – Sitewide Soil (0-10 ft bgs)

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Summary Statistics for Raw Data Sets with NDs using Detected Data Only

				Raw Statistics using Detected Observations							
Variable	Num Ds	NumNDs	% NDs	Minimum	Maximum	Mean	Median	SD	MAD/0.675	Skewness	CV
Arsenic (mg/kg)	94	3	3.09%	4	36.3	8.956	7.5	4.61	2.372	2.963	0.515
Benzo(a)pyrene (mg/kg)	36	0	0.00%	0.0039	0.505	0.145	0.099	0.129	0.0792	1.49	0.894
Lead (mg/kg)	119	0	0.00%	7.37	1416	123.5	56.14	215.3	46.3	4.056	1.744
Tetrachloroethene (mg/kg)	17	1	5.56%	0.00046	6.4	0.771	0.048	1.866	0.0694	2.659	2.421
Trichloroethene (mg/kg)	13	5	27.78%	0.0011	0.81	0.172	0.032	0.276	0.0378	1.606	1.599

APPENDIX R

ProUCL Output – Sitewide Soil (0-10 ft bgs)

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

General UCL Statistics for Data Sets with Non-Detects**User Selected Options**

Full Precision	OFF	
Confidence Coefficient	95%	
Number of Bootstrap Operations		2,000

Arsenic (mg/kg)**General Statistics**

Number of Valid Data	97	Number of Detected Data	94
Number of Distinct Detected Data	85	Number of Non-Detect Data	3
		Percent Non-Detects	3.09%

Raw Statistics

Minimum Detected	4	Minimum Detected	1.386
Maximum Detected	36.3	Maximum Detected	3.592
Mean of Detected	8.956	Mean of Detected	2.103
SD of Detected	4.61	SD of Detected	0.396
Minimum Non-Detect	0.25	Minimum Non-Detect	-1.386
Maximum Non-Detect	0.25	Maximum Non-Detect	-1.386

Log-transformed Statistics**UCL Statistics****Normal Distribution Test with Detected Values Only**

Lilliefors Test Statistic	0.194	Lilliefors Test Statistic	0.108
5% Lilliefors Critical Value	0.0914	5% Lilliefors Critical Value	0.0914

Data not Normal at 5% Significance Level**Lognormal Distribution Test with Detected Values Only**

Lilliefors Test Statistic	0.194	Lilliefors Test Statistic	0.108
5% Lilliefors Critical Value	0.0914	5% Lilliefors Critical Value	0.0914

Data not Lognormal at 5% Significance Level**Assuming Normal Distribution**

DL/2 Substitution Method		DL/2 Substitution Method	
Mean	8.683	Mean	1.974
SD	4.791	SD	0.826
95% DL/2 (t) UCL	9.491	95% H-Stat (DL/2) UCL	10.53

Assuming Lognormal Distribution**Maximum Likelihood Estimate(MLE) Method**

Mean	8.625	Mean in Log Scale	2.073
SD	4.89	SD in Log Scale	0.425
95% MLE (t) UCL	9.449	Mean in Original Scale	8.776
95% MLE (Tiku) UCL	9.447	SD in Original Scale	4.65

Log ROS Method

95% Percentile Bootstrap UCL	9.592
95% BCA Bootstrap UCL	9.766

Gamma Distribution Test with Detected Values Only

k star (bias corrected)	5.602	Data Distribution Test with Detected Values Only
Theta Star	1.599	Data do not follow a Discernable Distribution (0.05)
nu star	1053	

APPENDIX R

ProUCL Output – Sitewide Soil (0-10 ft bgs)

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

A-D Test Statistic	2.746	Nonparametric Statistics	
5% A-D Critical Value	0.754	Kaplan-Meier (KM) Method	
K-S Test Statistic	0.754	Mean	8.803
5% K-S Critical Value	0.0925	SD	4.595
Data not Gamma Distributed at 5% Significance Level		SE of Mean	0.469
		95% KM (t) UCL	9.582
		95% KM (z) UCL	9.574
		95% KM (jackknife) UCL	9.581
Assuming Gamma Distribution		95% KM (bootstrap t) UCL	9.788
Gamma ROS Statistics using Extrapolated Data	1E-09	95% KM (BCA) UCL	9.71
Minimum	36.3	95% KM (Percentile Bootstrap) UCL	9.635
Maximum	8.692	95% KM (Chebyshev) UCL	10.85
Mean	7.4	97.5% KM (Chebyshev) UCL	11.73
Median	4.775	99% KM (Chebyshev) UCL	13.47
SD	1.526		
k star	5.698		
Theta star		Potential UCLs to Use	
Nu star	296	95% KM (BCA) UCL	9.71
AppChi2	257.1		
95% Gamma Approximate UCL	10.01		
95% Adjusted Gamma UCL	10.03		

Note: DL/2 is not a recommended method.**Benzo(a)pyrene (mg/kg)****General Statistics**

Number of Valid Observations	36	Number of Distinct Observations	36
------------------------------	----	---------------------------------	----

Raw Statistics

Minimum	0.0039	Log-transformed Statistics	
Maximum	0.505	Minimum of Log Data	-5.547
Mean	0.145	Maximum of Log Data	-0.683
Median	0.099	Mean of log Data	-2.339
SD	0.129	SD of log Data	1.007
Coefficient of Variation	0.894		
Skewness	1.49		

Relevant UCL Statistics**Normal Distribution Test**

Shapiro Wilk Test Statistic	0.826	Lognormal Distribution Test	
Shapiro Wilk Critical Value	0.935	Shapiro Wilk Test Statistic	0.959
		Shapiro Wilk Critical Value	0.935

Data not Normal at 5% Significance Level**Data appear Lognormal at 5% Significance Level****Assuming Normal Distribution**

95% Student's-t UCL	0.181	Assuming Lognormal Distribution	
95% UCLs (Adjusted for Skewness)		95% H-UCL	0.241
95% Adjusted-CLT UCL	0.186	95% Chebyshev (MVUE) UCL	0.29
95% Modified-t UCL	0.182	97.5% Chebyshev (MVUE) UCL	0.348
		99% Chebyshev (MVUE) UCL	0.461

APPENDIX R

ProUCL Output – Sitewide Soil (0-10 ft bgs)

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Gamma Distribution Test

k star (bias corrected)

Theta Star

nu star

Approximate Chi Square Value (.05)

Adjusted Level of Significance

Adjusted Chi Square Value

Anderson-Darling Test Statistic

Anderson-Darling 5% Critical Value

Kolmogorov-Smirnov Test Statistic

Kolmogorov-Smirnov 5% Critical Value

Data appear Gamma Distributed at 5% Significance Level

Assuming Gamma Distribution

95% Approximate Gamma UCL

95% Adjusted Gamma UCL

Potential UCL to Use

Data Distribution

1.281 Data appear Gamma Distributed at 5% Significance Level

0.113

92.24

71.1 Nonparametric Statistics

0.0428 95% CLT UCL

0.18

70.25 95% Jackknife UCL

0.181

95% Standard Bootstrap UCL

0.179

0.267 95% Bootstrap-t UCL

0.188

0.769 95% Hall's Bootstrap UCL

0.188

0.083 95% Percentile Bootstrap UCL

0.181

0.15 95% BCA Bootstrap UCL

0.185

95% Chebyshev(Mean, Sd) UCL

0.239

97.5% Chebyshev(Mean, Sd) UCL

0.279

99% Chebyshev(Mean, Sd) UCL

0.359

0.188

0.19

Use 95% Approximate Gamma UCL

0.188

Lead (mg/kg)

General Statistics

Number of Valid Observations

119 Number of Distinct Observations

117

Raw Statistics

Minimum

7.37 Minimum of Log Data

1.997

Maximum

1416 Maximum of Log Data

7.256

Mean

123.5 Mean of log Data

4.161

Median

56.14 SD of log Data

1.03

SD

215.3

Coefficient of Variation

1.744

Skewness

4.056

Relevant UCL Statistics

Normal Distribution Test

Lilliefors Test Statistic

0.296 Lilliefors Test Statistic

0.0737

Lilliefors Critical Value

0.0812 Lilliefors Critical Value

0.0812

Data not Normal at 5% Significance Level

Lognormal Distribution Test

Data appear Lognormal at 5% Significance Level

Assuming Normal Distribution

95% Student's-t UCL

156.2

95% H-UCL

134.5

95% UCLs (Adjusted for Skewness)

95% Chebyshev (MVUE) UCL

162.4

95% Adjusted-CLT UCL

163.8

97.5% Chebyshev (MVUE) UCL

185.8

95% Modified-t UCL

157.4

99% Chebyshev (MVUE) UCL

231.8

Assuming Lognormal Distribution

APPENDIX R

ProUCL Output – Sitewide Soil (0-10 ft bgs)

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Gamma Distribution Test

k star (bias corrected)
 Theta Star
 nu star
 Approximate Chi Square Value (.05)
 Adjusted Level of Significance
 Adjusted Chi Square Value

Anderson-Darling Test Statistic
 Anderson-Darling 5% Critical Value
 Kolmogorov-Smirnov Test Statistic
 Kolmogorov-Smirnov 5% Critical Value

Data not Gamma Distributed at 5% Significance Level**Assuming Gamma Distribution**

95% Approximate Gamma UCL
 95% Adjusted Gamma UCL

Potential UCL to Use**Data Distribution**0.876 **Data appear Lognormal at 5% Significance Level**

140.9

208.5

176.1 **Nonparametric Statistics**

0.048 95% CLT UCL 156

175.7 95% Jackknife UCL 156.2

95% Standard Bootstrap UCL 156

5.643 95% Bootstrap-t UCL 170.3

0.788 95% Hall's Bootstrap UCL 163.6

0.145 95% Percentile Bootstrap UCL 158.5

0.0874 95% BCA Bootstrap UCL 169.4

95% Chebyshev(Mean, Sd) UCL 209.5

97.5% Chebyshev(Mean, Sd) UCL 246.8

99% Chebyshev(Mean, Sd) UCL 319.9

146.2

146.5

Use 95% H-UCL

134.5

Tetrachloroethene (mg/kg)**General Statistics**

Number of Valid Data

18 Number of Detected Data 17

Number of Distinct Detected Data

15 Number of Non-Detect Data 1

Percent Non-Detects 5.56%

Raw Statistics

Minimum Detected

0.00046 Minimum Detected -7.684

Maximum Detected

6.4 Maximum Detected 1.856

Mean of Detected

0.771 Mean of Detected -3.019

SD of Detected

1.866 SD of Detected 2.701

Minimum Non-Detect

0.0063 Minimum Non-Detect -5.067

Maximum Non-Detect

0.0063 Maximum Non-Detect -5.067

Log-transformed Statistics**UCL Statistics****Normal Distribution Test with Detected Values Only**

Shapiro Wilk Test Statistic

0.467 Shapiro Wilk Test Statistic 0.969

5% Shapiro Wilk Critical Value

0.892 5% Shapiro Wilk Critical Value 0.892

Data not Normal at 5% Significance Level**Data appear Lognormal at 5% Significance Level****Assuming Normal Distribution**

DL/2 Substitution Method

Mean

Assuming Lognormal Distribution

DL/2 Substitution Method

0.728 Mean -3.171

APPENDIX R

ProUCL Output – Sitewide Soil (0-10 ft bgs)

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

SD	1.819	SD	2.699
95% DL/2 (t) UCL	1.474	95% H-Stat (DL/2) UCL	46

Maximum Likelihood Estimate(MLE) Method

Mean	0.389	Mean in Log Scale	-3.237
SD	2.081	SD in Log Scale	2.779
95% MLE (t) UCL	1.243	Mean in Original Scale	0.728
95% MLE (Tiku) UCL	1.232	SD in Original Scale	1.819

95% Percentile Bootstrap UCL	1.481
95% BCA Bootstrap UCL	1.73

Gamma Distribution Test with Detected Values Only

k star (bias corrected)

Theta Star

nu star

A-D Test Statistic

5% A-D Critical Value

K-S Test Statistic

5% K-S Critical Value

Data Distribution Test with Detected Values Only

0.25 Data Follow Appr. Gamma Distribution at 5% Significance Level

3.077

8.514

1.12 Nonparametric Statistics

0.86 Kaplan-Meier (KM) Method

0.86 Mean
 0.728 |

0.229
 SD | 1.768 |

Data follow Appr. Gamma Distribution at 5% Significance Level

SE of Mean
 0.43 |

95% KM (t) UCL	1.475
----------------	-------

95% KM (z) UCL	1.434
----------------	-------

95% KM (jackknife) UCL	1.474
------------------------	-------

1E-09 95% KM (bootstrap t) UCL	6.848
--------------------------------	-------

6.4 95% KM (BCA) UCL	1.474
----------------------	-------

0.728 95% KM (Percentile Bootstrap) UCL	1.437
---	-------

0.038 95% KM (Chebyshev) UCL	2.6
------------------------------	-----

1.819 97.5% KM (Chebyshev) UCL	3.41
--------------------------------	------

0.204 99% KM (Chebyshev) UCL	5.001
------------------------------	-------

3.576

7.326 Potential UCLs to Use

2.351 95% KM (Chebyshev) UCL	2.6
------------------------------	-----

2.267

2.551

Assuming Gamma Distribution

Gamma ROS Statistics using Extrapolated Data

Minimum

Maximum

Mean

Median

SD

k star

Theta star

Nu star

AppChi2

95% Gamma Approximate UCL

95% Adjusted Gamma UCL

Note: DL/2 is not a recommended method.

APPENDIX R

ProUCL Output – Sitewide Soil (0-10 ft bgs)

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Trichloroethene (mg/kg)**General Statistics**

Number of Valid Data	18	Number of Detected Data	13
Number of Distinct Detected Data	13	Number of Non-Detect Data	5
		Percent Non-Detects	27.78%

Raw Statistics

Minimum Detected	0.0011	Minimum Detected	-6.812
Maximum Detected	0.81	Maximum Detected	-0.211
Mean of Detected	0.172	Mean of Detected	-3.347
SD of Detected	0.276	SD of Detected	2.096
Minimum Non-Detect	0.006	Minimum Non-Detect	-5.116
Maximum Non-Detect	0.0065	Maximum Non-Detect	-5.036

Log-transformed Statistics

Note: Data have multiple DLs - Use of KM Method is recommended	Number treated as Non-Detect	7
For all methods (except KM, DL/2, and ROS Methods),	Number treated as Detected	11
Observations < Largest ND are treated as NDs	Single DL Non-Detect Percentage	38.89%

UCL Statistics**Normal Distribution Test with Detected Values Only**

Shapiro Wilk Test Statistic	0.664	Shapiro Wilk Test Statistic	0.956
5% Shapiro Wilk Critical Value	0.866	5% Shapiro Wilk Critical Value	0.866
Data not Normal at 5% Significance Level		Data appear Lognormal at 5% Significance Level	

Lognormal Distribution Test with Detected Values Only**Assuming Normal Distribution**

DL/2 Substitution Method		DL/2 Substitution Method	
Mean	0.125	Mean	-4.018
SD	0.244	SD	2.083
95% DL/2 (t) UCL	0.226	95% H-Stat (DL/2) UCL	0.541

Assuming Lognormal Distribution**Maximum Likelihood Estimate(MLE) Method**

Mean	0.0259	Mean in Log Scale	-4.272
SD	0.334	SD in Log Scale	2.346
95% MLE (t) UCL	0.163	Mean in Original Scale	0.125
95% MLE (Tiku) UCL	0.178	SD in Original Scale	0.245
		95% Percentile Bootstrap UCL	0.223
		95% BCA Bootstrap UCL	0.258

Log ROS Method**Gamma Distribution Test with Detected Values Only**

k star (bias corrected)	0.368	Data appear Gamma Distributed at 5% Significance Level	
Theta Star	0.468		
nu star	9.575		

Data Distribution Test with Detected Values Only**A-D Test Statistic****5% A-D Critical Value****K-S Test Statistic****0.619 Nonparametric Statistics****0.807 Kaplan-Meier (KM) Method**

0.807	Mean	0.125
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APPENDIX R

ProUCL Output – Sitewide Soil (0-10 ft bgs)

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

5% K-S Critical Value	0.253	SD	0.238
Data appear Gamma Distributed at 5% Significance Level		SE of Mean	0.0583
		95% KM (t) UCL	0.226
Assuming Gamma Distribution		95% KM (z) UCL	0.221
Gamma ROS Statistics using Extrapolated Data		95% KM (jackknife) UCL	0.225
Minimum	1E-09	95% KM (bootstrap t) UCL	0.277
Maximum	0.81	95% KM (BCA) UCL	0.232
Mean	0.124	95% KM (Percentile Bootstrap) UCL	0.231
Median	0.0115	95% KM (Chebyshev) UCL	0.379
SD	0.245	97.5% KM (Chebyshev) UCL	0.489
k star	0.144	99% KM (Chebyshev) UCL	0.705
Theta star	0.862		
Nu star	5.201	Potential UCLs to Use	
AppChi2	1.246	95% KM (Chebyshev) UCL	0.379
95% Gamma Approximate UCL	0.52		
95% Adjusted Gamma UCL	0.604		

Note: DL/2 is not a recommended method.

APPENDIX S**TABLE 10.1****RAGS D ADULT Lead Worksheet**

Calculations of Blood Lead Concentrations – Surface Soil – Industrial Worker

*St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri**Soil (0-2")***1. Lead Screening Questions**

Medium	Lead Concentration used in Model Run		Basis for Lead Concentration Used For Model Run	Lead Screening Concentration		Basis for Lead Screening Level
	Value	Units		Value	Units	
Soil	137.79	mg/kg	Average Detected Value	800	mg/kg	Recommended Soil Screening Level

2. Lead Model Questions

Question	Response
What lead model was used? Provide reference and version	USEPA Adult Lead Methodology, Version dated 5/19/05.
If the EPA Adult Lead Model (ALM) was not used provide rationale for model selected.	N/A
Where are the input values located in the risk assessment report?	Located in Appendix L, 10.2.
What statistics were used to represent the exposure concentration terms and where are the data on concentrations in the risk assessment that support use of these statistics?	Exposure point concentration was based on the arithmetic mean of lead concentrations in combined surface and subsurface soil; Appendix J, Table 3.1.
What was the point of exposure and location?	Combined Surface and Subsurface Soil (0 – 2 ft) – St. Louis Ordnance Plant, Former Hanley Area - St. Louis, Missouri.
Where are the output values located in the risk assessment report?	Located in Appendix L, 10.2.
What GSD value was used? If this is outside the recommended range of 1.8-2.1), provide rationale in Appendix <Y>.	Default values were used: GSD = 2.0 for Northeast; GSD = 2.1 for All, White, South, and West; GSD= 2.2 for Black and Midwest; GSD=2.3 for Mexican. Values from NHANES III Analysis (USEPA, 2002).
What baseline blood lead concentration (PbB0) value was used? If this is outside the default range of 1.7 to 2.2 provide rationale in Appendix <Y>.	Default values were used: PbB0 = 1.4 µg/dL for South and West; PbB0 = 1.5 µg/dL for All, White, and Midwest; PbB0 = 1.7 for Mexican; PbB0 = 2.0 µg/dL for Northeast. Value from NHANES III (USEPA, 2002).
Was the default exposure frequency (EF; 219 days/year) used?	No. A value of 250 days/year was used for the industrial worker scenario.
Was the default BKSF used (0.4 µg/dL per µg/day) used?	Yes.
Was the default absorption fraction (AF; 0.12) used?	Yes.
Was the default soil ingestion rate (IR; 50 mg/day) used?	Yes. An IR value of 50 mg/day was used.
If non-default values were used for any of the parameters listed above, where is the rationale for the values located in the risk assessment report?	Discussion of parameters in Section 7.3.3.

1. Attach the ALM spreadsheet output file upon which the Risk Based Remediation Goal (RBRG) was based and description of rationale for parameters used. For additional information, see www.epa.gov/superfund/programs/lead

APPENDIX S**TABLE 10.1****RAGS D ADULT Lead Worksheet***Calculations of Blood Lead Concentrations – Surface Soil – Industrial Worker**St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri**Soil (0-2')***3. Final Result**

Medium	Result	Comment/RBRG 1
Surface Soil (0 – 2 ft)	An input value of 137.79 ppm in combined surface and subsurface soil at SLOP (0-2') results in geometric mean blood lead levels ranging from 1.6 to 2.2 µg/dL for women of child-bearing age in homogeneous and heterogeneous populations. These values are below the target baseline blood lead concentration of 10 µg/dL. The 95th percentile fetal blood lead concentrations range from 4.8 to 6.8 µg/dL. The probabilities that the fetal blood lead levels exceed 10 µg/dL range from 0.4% to 1.7%. These values are below the blood lead goal as described in the 1994 OSWER Directive of no more than 5% of children (fetuses of exposed women) exceeding 10 µg/dL blood lead.	PRG not calculated.

1. Attach the ALM spreadsheet output file upon which the Risk Based Remediation Goal (RBRG) was based and description of rationale for parameters used. For additional information, see www.epa.gov/superfund/programs/lead

APPENDIX S

TABLE 10.2

Calculations of Blood Lead Concentrations (PbBs)

Surface Soil (0-2 ft) - Industrial Worker Scenario

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

USEPA Technical Review Workgroup for Lead, Adult Lead Committee

Version date 05/19/05

EDIT RED CELLS

Exposure Variable	Description of Exposure Variable	Units	Region OR Ethnic GSDi and PbBo Data from NHANES III Analysis							
			All/All	All/White	All/Black	All/Mexican	Northeast/All	Midwest/All	South/All	West/All
PbS	Soil lead concentration	mg/g or ppm	137.79	137.79	137.79	137.79	137.79	137.79	137.79	137.79
R _{fetal/maternal}	Fetal/maternal PbB ratio	--	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
BKSF	Biokinetic Slope Factor	mg/dL per mg/day	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
GSD _i	Geometric standard deviation PbB	--	2.1	2.1	2.2	2.3	2.0	2.2	2.1	2.1
PbB ₀	Baseline PbB	mg/dL	1.5	1.5	1.8	1.7	2.0	1.5	1.4	1.4
IR _S	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050
IR _{S+D}	Total ingestion rate of outdoor soil and indoor dust	g/day	--	--	--	--	--	--	--	--
W _S	Weighting factor; fraction of IR _{S+D} ingested as outdoor soil	--	--	--	--	--	--	--	--	--
K _{SD}	Mass fraction of soil in dust	--	--	--	--	--	--	--	--	--
AF _{S,D}	Absorption fraction (same for soil and dust)	--	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
EF _{S,D}	Exposure frequency (same for soil and dust)	days/yr	250	250	250	250	250	250	250	250
AT _{S,D}	Averaging time (same for soil and dust)	days/yr	365	365	365	365	365	365	365	365
PbB _{adult}	PbB of adult worker, geometric mean	mg/dL	1.8	1.7	2.0	1.9	2.2	1.8	1.6	1.6
PbB _{fetal, 0.95}	95th percentile PbB among fetuses of adult workers	mg/dL	5.4	5.1	6.4	6.8	6.2	5.7	4.8	5.0
PbB _t	Target PbB level of concern (e.g., 10 ug/dL)	mg/dL	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
P(PbB _{fetal} > PbB _t)	Probability that fetal PbB > PbB _t , assuming lognormal distribution	%	0.7%	0.5%	1.3%	1.7%	1.0%	0.9%	0.4%	0.5%

¹ Equation 1 does not apportion exposure between soil and dust ingestion (excludes W_S, K_{SD}).

When IR_S = IR_{S+D} and W_S = 1.0, the equations yield the same PbB_{fetal, 0.95}.

APPENDIX S

TABLE 10.3

RAGS D Adult Lead Worksheet

Calculations of Blood Lead Concentrations – Subsurface Soil – Construction Worker

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Soil (0-10')

1. Lead Screening Questions

Medium	Lead Concentration used in Model Run		Basis for Lead Concentration Used For Model Run	Lead Screening Concentration		Basis for Lead Screening Level
	Value	Units		Value	Units	
Soil	123.48	mg/kg	Average Detected Value	800	mg/kg	Recommended Soil Screening Level

2. Lead Model Questions

Question	Response
What lead model was used? Provide reference and version	USEPA Adult Lead Methodology, Version dated 5/19/05.
If the EPA Adult Lead Model (ALM) was not used provide rationale for model selected.	N/A
Where are the input values located in the risk assessment report?	Located in Appendix L, Table 10.4.
What statistics were used to represent the exposure concentration terms and where are the data on concentrations in the risk assessment that support use of these statistics?	Exposure point concentration was based on the arithmetic mean of lead concentrations in combined surface and subsurface soil; Appendix J, Table 3.2.
What was the point of exposure and location?	Subsurface Soil (0 – 10 ft) – St. Louis Ordnance Plant, Former Hanley Area - St. Louis, Missouri.
Where are the output values located in the risk assessment report?	Located in Appendix L, Table 10.4.
What GSD value was used? If this is outside the recommended range of 1.8-2.1, provide rationale in Appendix <Y>.	Default values were used: GSD = 2.0 for Northeast; GSD = 2.1 for All, White, South, and West; GSD= 2.2 for Black and Midwest; GSD=2.3 for Mexican. Values from NHANES III Analysis (USEPA, 2002).
What baseline blood lead concentration (PbB0) value was used? If this is outside the default range of 1.7 to 2.2 provide rationale in Appendix <Y>.	Default values were used: PbB0 = 1.4 ug/dL for South and West; PbB0 = 1.5 ug/dL for All, White, and Midwest; PbB0 = 1.7 for Mexican; PbB0 = 2.0 ug/dL for Northeast. Value from NHANES III (USEPA, 2002).
Was the default exposure frequency (EF; 219 days/year) used?	No. A value of 250 days/year was used for the construction worker scenario.
Was the default BCSF used (0.4 ug/dL per ug/day) used?	Yes.
Was the default absorption fraction (AF; 0.12) used?	Yes.
Was the default soil ingestion rate (IR; 50 mg/day) used?	No. An IR value of 330 mg/day was used.
If non-default values were used for any of the parameters listed above, where is the rationale for the values located in the risk assessment report?	Discussion of parameters in Section 7.3.3.

1. Attach the ALM spreadsheet output file upon which the Risk Based Remediation Goal (RBRG) was based and description of rationale for parameters used. For additional information, see www.epa.gov/superfund/programs/lead

APPENDIX S**TABLE 10.3****RAGS D Adult Lead Worksheet**

Calculations of Blood Lead Concentrations – Subsurface Soil – Construction Worker

*St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri**Soil (0-10')***3. Final Result**

Medium	Result	Comment/RBRG 1
Subsurface Soil (0 – 10 ft)	An input value of 123.48 ppm in combined surface and subsurface soil at SLOP (0-2') results in geometric mean blood lead levels ranging from 2.7 to 3.3 µg/dL for women of child-bearing age in homogeneous and heterogeneous populations. These values are below the target baseline blood lead concentration of 10 µg/dL. The 95th percentile fetal blood lead concentrations range from 8.1 to 10.7 µg/dL. The probabilities that the fetal blood lead levels exceed 10 µg/dL range from 2.7% to 5.9%. The value for one group (All/Mexican) is above the blood lead goal as described in the 1994 OSWER Directive of no more than 5% of children (fetuses of exposed women) exceeding 10 µg/dL blood lead.; all other values are below the blood lead goal.	PRG not calculated.

1. Attach the ALM spreadsheet output file upon which the Risk Based Remediation Goal (RBRG) was based and description of rationale for parameters used. For additional information, see www.epa.gov/superfund/programs/lead

APPENDIX S

TABLE 10.4

Calculations of Blood Lead Concentrations (PbBs)

Subsurface Soil (0-10 ft) - Construction Worker Scenario

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

USEPA Technical Review Workgroup for Lead, Adult Lead Committee

Version date 05/19/05

EDIT RED CELLS

Exposure Variable	Description of Exposure Variable	Units	Region OR Ethnic GSDi and PbBo Data from NHANES III Analysis							
			All/All	All/White	All/Black	All/Mexican	Northeast/All	Midwest/All	South/All	West/All
PbS	Soil lead concentration	µg/g or ppm	123.48	123.48	123.48	123.48	123.48	123.48	123.48	123.48
R _{fetal/maternal}	Fetal/maternal PbB ratio	--	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
BKSF	Biokinetic Slope Factor	µg/dL per µg/day	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
GSD _i	Geometric standard deviation PbB	--	2.1	2.1	2.2	2.3	2.0	2.2	2.1	2.1
PbB ₀	Baseline PbB	µg/dL	1.5	1.5	1.8	1.7	2.0	1.5	1.4	1.4
IR _S	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.330	0.330	0.330	0.330	0.330	0.330	0.330	0.330
IR _{S+D}	Total ingestion rate of outdoor soil and indoor dust	g/day	--	--	--	--	--	--	--	--
W _S	Weighting factor; fraction of IR _{S+D} ingested as outdoor soil	--	--	--	--	--	--	--	--	--
K _{SD}	Mass fraction of soil in dust	--	--	--	--	--	--	--	--	--
AF _{S,D}	Absorption fraction (same for soil and dust)	--	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
EF _{S,D}	Exposure frequency (same for soil and dust)	days/yr	250	250	250	250	250	250	250	250
AT _{S,D}	Averaging time (same for soil and dust)	days/yr	365	365	365	365	365	365	365	365
PbB _{adult}	PbB of adult worker, geometric mean	µg/dL	2.9	2.8	3.1	3.0	3.3	2.9	2.7	2.7
PbB _{fetal, 0.95}	95th percentile PbB among fetuses of adult workers	µg/dL	8.8	8.4	10.0	10.7	9.3	9.3	8.1	8.4
PbB _t	Level of concern (e.g., 10 µg/dL)	µg/dL	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
P(PbB _{fetal} > PbB _t)	Probability that fetal PbB > PbB _t , assuming lognormal distribution	%	3.5%	3.0%	5.0%	5.9%	4.1%	4.1%	2.7%	3.0%

¹ Equation 1 does not apportion exposure between soil and dust ingestion (excludes W_S, K_{SD}).

When IR_S = IR_{S+D} and W_S = 1.0, the equations yield the same PbB_{fetal, 0.95}.

APPENDIX T

TABLE 11.1

RAGS D IEUBK Lead Worksheet

Child (Age 0 – 84 Months), Subsurface Soil (0-10 ft) – Exposure Unit A

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

1. Lead Screening Questions

Medium	Lead Concentration Used in Model Run		Basis for Lead Concentration Used For Model Run	Lead Screening Concentration		Basis for Lead Screening Level
	Value	Units		Value	Units	
Soil	236	mg/kg	Average Detected Value	400	mg/kg	Recommended Soil Screening Level
Water	4.0	µg/L	Model Default	15	µg/L	Recommended Drinking Water Action Level

2. Lead Model Questions

Question	Response for Residential Lead Model
What lead model (version and date was used)?	Lead Model for Windows, Version 1.0 Build 264
Where are the input values located in the risk assessment report?	Located in IEUBKwin OUTPUT (Attached as Appendix M, Tables 11.2 and 11.3)
What range of media concentrations were used for the model?	28.345 – 1022.9 mg/kg
What statistics were used to represent the exposure concentration terms and where are the data on concentrations in the risk assessment that support use of these statistics?	Arithmetic Mean Concentration
Was soil sample taken from top 2 cm? If not, why?	No. Surface soil and subsurface data set was used to represent subsurface soil.
Was soil sample sieved? What size screen was used? If not sieved, provide rationale.	No -- Soil samples were collected for multiple analyses.
What was the point of exposure/location?	St. Louis Ordnance Plant, Former Hanley Area - St. Louis, Missouri
Where are the output values located in the risk assessment report?	IEUBKwin OUTPUT (Attached as Appendix M, Tables 11.2 and 11.3)
Was the model run using default values only?	No – Assumed site-specific arithmetic mean concentration of lead in soil.
Was the default soil bioavailability used?	Yes – Default is 30%
Was the default soil ingestion rate used?	Yes -- Default values for 7 age groups are 85, 135, 135, 100, 090, and 85 mg/day
If non-default values were used, where is the rationale for the values located in the risk assessment report?	Located in Section 7.3.3.

3. Final Result

Medium	Result	Comment/PRG 1
Subsurface Soil (0-10 ft)	Input value of 236 mg/kg in subsurface soil and 4 µg/L in groundwater results in 0.620% of children above a blood lead level of 10 µg/dL. Geometric mean blood lead = 3.088 µg/dL. This is below the blood lead goal as described in the 1994 OSWER Directive of no more than 5% of children exceeding 10 µg/dL blood lead.	PRG not calculated.

LEAD MODEL FOR WINDOWS Version 1.0

Model Version: 1.0 Build 264

User Name: CH2MHILL

Date: 10/23/08

Site Name: St. Louis Ordnance Plant, Former Hanley Area - St. Louis, Missouri

Operable Unit: SUBUNIT B

Run Mode: Site Risk Assessment

Soil/Dust Data

Values Based on Arithmetic Mean- Subunit B

The time step used in this model run: 1 - Every 4 Hours (6 times a day).

***** Air *****

Indoor Air Pb Concentration: 30.000 percent of outdoor.

Other Air Parameters:

Age	Time Outdoors (hours)	Ventilation Rate (m ³ /day)	Lung Absorption (%)	Outdoor Air Pb Conc (ug Pb/m ³)
.5-1	1.000	2.000	32.000	0.100
1-2	2.000	3.000	32.000	0.100
2-3	3.000	5.000	32.000	0.100
3-4	4.000	5.000	32.000	0.100
4-5	4.000	5.000	32.000	0.100
5-6	4.000	7.000	32.000	0.100
6-7	4.000	7.000	32.000	0.100

***** Diet *****

Age Diet Intake(ug/day)

.5-1	2.260
1-2	1.960
2-3	2.130
3-4	2.040
4-5	1.950
5-6	2.050
6-7	2.220

***** Drinking Water *****

Water Consumption:

Age Water (L/day)

.5-1	0.200
1-2	0.500
2-3	0.520
3-4	0.530
4-5	0.550
5-6	0.580
6-7	0.590

Drinking Water Concentration: 4.000 ug Pb/L

***** Soil & Dust *****

Multiple Source Analysis Used

Average multiple source concentration: 197.579 ug/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700
 Outdoor airborne lead to indoor household dust lead concentration: 100.000
 Use alternate indoor dust Pb sources? No

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
.5-1	267.970	197.579
1-2	267.970	197.579
2-3	267.970	197.579
3-4	267.970	197.579
4-5	267.970	197.579
5-6	267.970	197.579
6-7	267.970	197.579

***** Alternate Intake *****

Age	Alternate (ug Pb/day)
.5-1	0.000
1-2	0.000
2-3	0.000
3-4	0.000
4-5	0.000
5-6	0.000
6-7	0.000

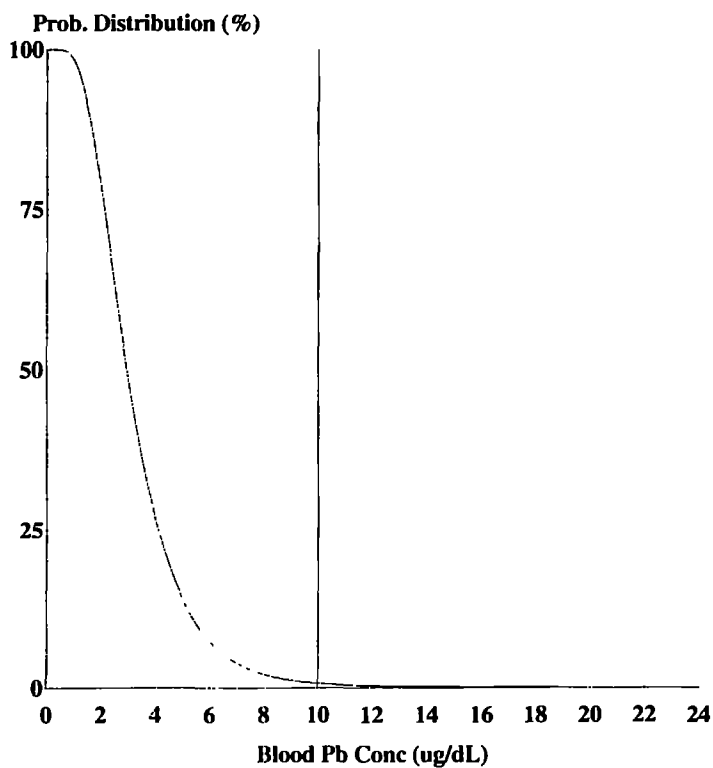
***** Maternal Contribution: Infant Model *****

Maternal Blood Concentration: 2.500 ug Pb/dL

CALCULATED BLOOD LEAD AND LEAD UPTAKES:

Year	Air (ug/day)	Diet (ug/day)	Alternate (ug/day)	Water (ug/day)
.5-1	0.021	1.045	0.000	0.370
1-2	0.034	0.895	0.000	0.913
2-3	0.062	0.984	0.000	0.961
3-4	0.067	0.953	0.000	0.991
4-5	0.067	0.930	0.000	1.050
5-6	0.093	0.986	0.000	1.116
6-7	0.093	1.072	0.000	1.139

Year	Soil+Dust (ug/day)	Total (ug/day)	Blood (ug/dL)
.5-1	5.408	6.844	3.7
1-2	8.480	10.322	4.3
2-3	8.582	10.590	4.0
3-4	8.677	10.688	3.7
4-5	6.563	8.610	3.1
5-6	5.953	8.147	2.6
6-7	5.645	7.950	2.3



Cutoff = 10.000 ug/dl
Geo Mean = 3.088
GSD = 1.600
% Above = 0.620

Age Range = 0 to 84 months
Time Step = Every 4 Hours
Run Mode = Site Risk Assessment
Comment = SUBUNIT A

APPENDIX T

TABLE 11.4

RAGS D IEUBK Lead Worksheet

Child (Age 0 – 84 Months), Subsurface Soil (0-10 ft) – Exposure Unit B

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

1. Lead Screening Questions

Medium	Lead Concentration Used in Model Run		Basis for Lead Concentration Used For Model Run	Lead Screening Concentration		Basis for Lead Screening Level
	Value	Units		Value	Units	
Soil	267.97	mg/kg	Average Detected Value	400	mg/kg	Recommended Soil Screening Level
Water	4.0	µg/L	Model Default	15	µg/L	Recommended Drinking Water Action Level

2. Lead Model Questions

Question	Response for Residential Lead Model
What lead model (version and date) was used?	Lead Model for Windows, Version 1.0 Build 264
Where are the input values located in the risk assessment report?	Located in IEUBKwin OUTPUT (Attached as Appendix M, Tables 11.5 and 11.6)
What range of media concentrations were used for the model?	31.0–1416.0 mg/kg
What statistics were used to represent the exposure concentration terms and where are the data on concentrations in the risk assessment that support use of these statistics?	Arithmetic Mean Concentration
Was soil sample taken from top 2 cm? If not, why?	No. Surface soil and subsurface data set was used to represent subsurface soil.
Was soil sample sieved? What size screen was used? If not sieved, provide rationale.	No – Soil samples were collected for multiple analyses.
What was the point of exposure/location?	St. Louis Ordnance Plant, Former Hanley Area - St. Louis, Missouri
Where are the output values located in the risk assessment report?	IEUBKwin OUTPUT (Attached as Appendix M, Tables 11.5 and 11.6)
Was the model run using default values only?	No – Assumed site-specific arithmetic mean concentration of lead in soil.
Was the default soil bioavailability used?	Yes – Default is 30%
Was the default soil ingestion rate used?	Yes – Default values for 7 age groups are 85, 135, 135, 100, 090, and 85 mg/day
If non-default values were used, where is the rationale for the values located in the risk assessment report?	Located in Section 7.3.3.

3. Final Result

Medium	Result	Comment/PRG 1
Subsurface Soil (0-10 ft)	Input value of 267.97mg/kg in subsurface soil and 4 µg/L in groundwater results in 1.034% of children above a blood lead level of 10 µg/dL. Geometric mean blood lead = 3.371 µg/dL. This is below the blood lead goal as described in the 1994 OSWER Directive of no more than 5% of children exceeding 10 µg/dL blood lead.	PRG not calculated.

LEAD MODEL FOR WINDOWS Version 1.0

=====
Model Version: 1.0 Build 264

User Name: CH2MHILL

Date: 10/23/08

Site Name: St. Louis Ordnance Plant, Former Hanley Area - St. Louis, Missouri

Operable Unit: SUBUNIT B

Run Mode: Site Risk Assessment

Soil/Dust Data

Values Based on Arithmetic Mean- Subunit B

=====
The time step used in this model run: 1 - Every 4 Hours (6 times a day).

***** Air *****

Indoor Air Pb Concentration: 30.000 percent of outdoor.

Other Air Parameters:

Age	Time Outdoors (hours)	Ventilation Rate (m ³ /day)	Lung Absorption (%)	Outdoor Air Pb Conc (ug Pb/m ³)
.5-1	1.000	2.000	32.000	0.100
1-2	2.000	3.000	32.000	0.100
2-3	3.000	5.000	32.000	0.100
3-4	4.000	5.000	32.000	0.100
4-5	4.000	5.000	32.000	0.100
5-6	4.000	7.000	32.000	0.100
6-7	4.000	7.000	32.000	0.100

***** Diet *****

Age	Diet Intake(ug/day)
.5-1	2.260
1-2	1.960
2-3	2.130
3-4	2.040
4-5	1.950
5-6	2.050
6-7	2.220

***** Drinking Water *****

Water Consumption:

Age	Water (L/day)
.5-1	0.200
1-2	0.500
2-3	0.520
3-4	0.530
4-5	0.550
5-6	0.580
6-7	0.590

Drinking Water Concentration: 4.000 ug Pb/L

***** Soil & Dust *****

Multiple Source Analysis Used

Average multiple source concentration: 197.579 ug/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700
 Outdoor airborne lead to indoor household dust lead concentration: 100.000
 Use alternate indoor dust Pb sources? No

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
.5-1	267.970	197.579
1-2	267.970	197.579
2-3	267.970	197.579
3-4	267.970	197.579
4-5	267.970	197.579
5-6	267.970	197.579
6-7	267.970	197.579

***** Alternate Intake *****

Age	Alternate (ug Pb/day)
.5-1	0.000
1-2	0.000
2-3	0.000
3-4	0.000
4-5	0.000
5-6	0.000
6-7	0.000

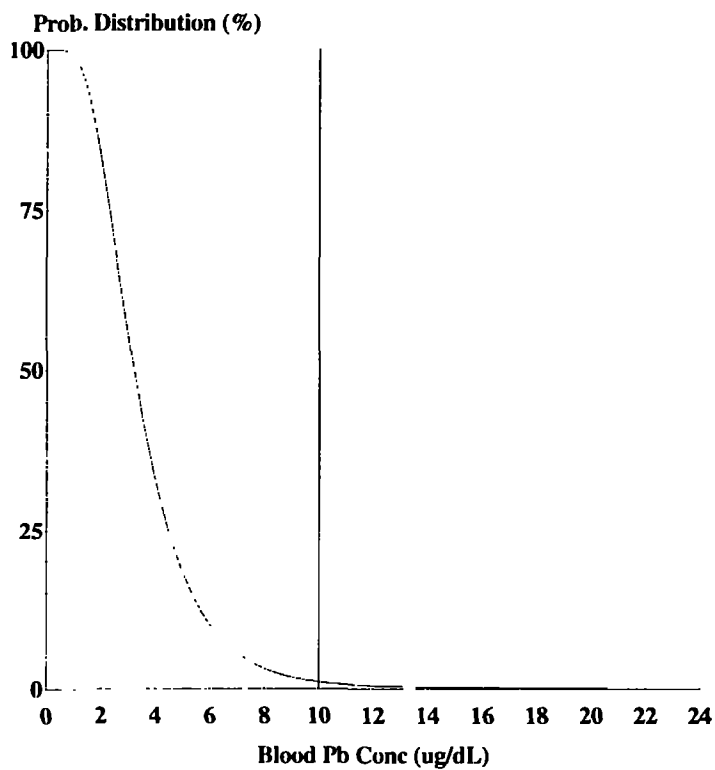
***** Maternal Contribution: Infant Model *****

Maternal Blood Concentration: 2.500 ug Pb/dL

 CALCULATED BLOOD LEAD AND LEAD UPTAKES:

Year	Air (ug/day)	Diet (ug/day)	Alternate (ug/day)	Water (ug/day)
.5-1	0.021	1.045	0.000	0.370
1-2	0.034	0.895	0.000	0.913
2-3	0.062	0.984	0.000	0.961
3-4	0.067	0.953	0.000	0.991
4-5	0.067	0.930	0.000	1.050
5-6	0.093	0.986	0.000	1.116
6-7	0.093	1.072	0.000	1.139

Year	Soil+Dust (ug/day)	Total (ug/day)	Blood (ug/dL)
.5-1	5.408	6.844	3.7
1-2	8.480	10.322	4.3
2-3	8.582	10.590	4.0
3-4	8.677	10.688	3.7
4-5	6.563	8.610	3.1
5-6	5.953	8.147	2.6
6-7	5.645	7.950	2.3



Cutoff = 10.000 ug/dl
Geo Mean = 3.371
GSD = 1.600
% Above = 1.034

Age Range = 0 to 84 months
Time Step = Every 4 Hours
Run Mode = Site Risk Assessment
Comment = SUBUNIT B

APPENDIX T

TABLE 11.7

RAGS D IEUBK Lead Worksheet

Child (Age 0 – 84 Months), Subsurface Soil (0-10 ft) – Exposure Unit F

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

1. Lead Screening Questions

Medium	Lead Concentration Used in Model Run		Basis for Lead Concentration Used For Model Run	Lead Screening Concentration		Basis for Lead Screening Level
	Value	Units		Value	Units	
Soil	136.45	mg/kg	Average Detected Value	400	mg/kg	Recommended Soil Screening Level
Water	4.0	µg/L	Model Default	15	µg/L	Recommended Drinking Water Action Level

2. Lead Model Questions

Question	Response for Residential Lead Model
What lead model (version and date was used?	Lead Model for Windows, Version 1.0 Build 264
Where are the input values located in the risk assessment report?	Located in IEUBKwin OUTPUT (Attached as Appendix M, Tables 11.8 and 11.9)
What range of media concentrations were used for the model?	11.9-1118.0 mg/kg
What statistics were used to represent the exposure concentration terms and where are the data on concentrations in the risk assessment that support use of these statistics?	Arithmetic Mean Concentration
Was soil sample taken from top 2 cm? If not, why?	No. Surface soil and subsurface data set was used to represent subsurface soil.
Was soil sample sieved? What size screen was used? If not sieved, provide rationale.	No – Soil samples were collected for multiple analyses.
What was the point of exposure/location?	St. Louis Ordnance Plant, Former Hanley Area - St. Louis, Missouri
Where are the output values located in the risk assessment report?	IEUBKwin OUTPUT (Attached as Appendix M, Tables 11.8 and 11.9)
Was the model run using default values only?	No – Assumed site-specific arithmetic mean concentration of lead in soil.
Was the default soil bioavailability used?	Yes – Default is 30%
Was the default soil ingestion rate used?	Yes – Default values for 7 age groups are 85, 135, 135, 100, 090, and 85 mg/day
If non-default values were used, where is the rationale for the values located in the risk assessment report?	Located in Section 7.3.3.

3. Final Result

Medium	Result	Comment/PRG 1
Subsurface Soil (0-10 ft)	Input value of 136.45 mg/kg in subsurface soil and 4 µg/L in groundwater results in 0.060% of children above a blood lead level of 10 µg/dL. Geometric mean blood lead = 2.180 µg/dL. This is below the blood lead goal as described in the 1994 OSWER Directive of no more than 5% of children exceeding 10 µg/dL blood lead.	PRG not calculated.

LEAD MODEL FOR WINDOWS Version 1.0

Model Version: 1.0 Build 264

User Name: CH2MHILL

Date: 10/23/08

Site Name: St. Louis Ordnance Plant, Former Hanley Area - St. Louis, Missouri

Operable Unit: SUBUNIT F

Run Mode: Site Risk Assessment

Soil/Dust Data

Values Based on Arithmetic Mean- Subunit F

The time step used in this model run: 1 - Every 4 Hours (6 times a day).

***** Air *****

Indoor Air Pb Concentration: 30.000 percent of outdoor.

Other Air Parameters:

Age	Time Outdoors (hours)	Ventilation Rate (m ³ /day)	Lung Absorption (%)	Outdoor Air Pb Conc (ug Pb/m ³)
.5-1	1.000	2.000	32.000	0.100
1-2	2.000	3.000	32.000	0.100
2-3	3.000	5.000	32.000	0.100
3-4	4.000	5.000	32.000	0.100
4-5	4.000	5.000	32.000	0.100
5-6	4.000	7.000	32.000	0.100
6-7	4.000	7.000	32.000	0.100

***** Diet *****

Age Diet Intake(ug/day)

.5-1	2.260
1-2	1.960
2-3	2.130
3-4	2.040
4-5	1.950
5-6	2.050
6-7	2.220

***** Drinking Water *****

Water Consumption:

Age Water (L/day)

.5-1	0.200
1-2	0.500
2-3	0.520
3-4	0.530
4-5	0.550
5-6	0.580
6-7	0.590

Drinking Water Concentration: 4.000 ug Pb/L

***** Soil & Dust *****

Multiple Source Analysis Used

Average multiple source concentration: 105.515 ug/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700
 Outdoor airborne lead to indoor household dust lead concentration: 100.000
 Use alternate indoor dust Pb sources? No

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
.5-1	136.450	105.515
1-2	136.450	105.515
2-3	136.450	105.515
3-4	136.450	105.515
4-5	136.450	105.515
5-6	136.450	105.515
6-7	136.450	105.515

***** Alternate Intake *****

Age	Alternate (ug Pb/day)
.5-1	0.000
1-2	0.000
2-3	0.000
3-4	0.000
4-5	0.000
5-6	0.000
6-7	0.000

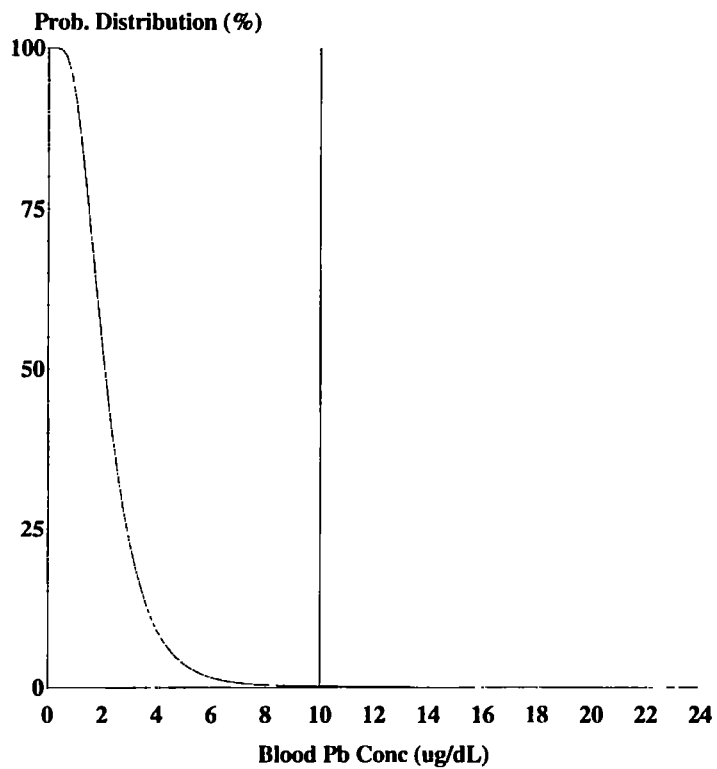
***** Maternal Contribution: Infant Model *****

Maternal Blood Concentration: 2.500 ug Pb/dL

 CALCULATED BLOOD LEAD AND LEAD UPTAKES:

Year	Air (ug/day)	Diet (ug/day)	Alternate (ug/day)	Water (ug/day)
.5-1	0.021	1.075	0.000	0.381
1-2	0.034	0.926	0.000	0.945
2-3	0.062	1.014	0.000	0.990
3-4	0.067	0.978	0.000	1.016
4-5	0.067	0.946	0.000	1.068
5-6	0.093	0.999	0.000	1.131
6-7	0.093	1.085	0.000	1.153

Year	Soil+Dust (ug/day)	Total (ug/day)	Blood (ug/dL)
.5-1	2.899	4.376	2.4
1-2	4.572	6.478	2.7
2-3	4.605	6.672	2.5
3-4	4.638	6.699	2.4
4-5	3.477	5.558	2.0
5-6	3.144	5.367	1.7
6-7	2.976	5.307	1.5



Cutoff = 10.000 ug/dl
Geo Mean = 2.180
GSD = 1.600
% Above = 0.060

Age Range = 0 to 84 months
Time Step = Every 4 Hours
Run Mode = Site Risk Assessment
Comment = SUBUNIT F

APPENDIX T
TABLE 11.10
RAGS D IEUBK Lead Worksheet
Child (Age 0 – 84 Months), Subsurface Soil (0-10 ft) – Exposure Unit G
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

1. Lead Screening Questions

Medium	Lead Concentration Used in Model Run		Basis for Lead Concentration Used For Model Run	Lead Screening Concentration		Basis for Lead Screening Level
	Value	Units		Value	Units	
Soil	133.45	mg/kg	Average Detected Value	400	mg/kg	Recommended Soil Screening Level
Water	4.0	µg/L	Model Default	15	µg/L	Recommended Drinking Water Action Level

2. Lead Model Questions

Question	Response for Residential Lead Model
What lead model (version and date was used)?	Lead Model for Windows, Version 1.0 Build 264
Where are the input values located in the risk assessment report?	Located in IEUBKwin OUTPUT (Attached as Appendix M, Tables 11.11 and 11.12)
What range of media concentrations were used for the model?	11-983 mg/kg
What statistics were used to represent the exposure concentration terms and where are the data on concentrations in the risk assessment that support use of these statistics?	Arithmetic Mean Concentration
Was soil sample taken from top 2 cm? If not, why?	No. Surface soil and subsurface data set was used to represent subsurface soil.
Was soil sample sieved? What size screen was used? If not sieved, provide rationale.	No – Soil samples were collected for multiple analyses.
What was the point of exposure/location?	St. Louis Ordnance Plant, Former Hanley Area - St. Louis, Missouri
Where are the output values located in the risk assessment report?	IEUBKwin OUTPUT (Attached as Appendix M, Tables 11.11 and 11.12)
Was the model run using default values only?	No – Assumed site-specific arithmetic mean concentration of lead in soil.
Was the default soil bioavailability used?	Yes – Default is 30%
Was the default soil ingestion rate used?	Yes – Default values for 7 age groups are 85, 135, 135, 100, 090, and 85 mg/day
If non-default values were used, where is the rationale for the values located in the risk assessment report?	Located in Section 7.3.3.

3. Final Result

Medium	Result	Comment/PRG 1
Subsurface Soil (0-10 ft)	Input value of 133.45 mg/kg in subsurface soil and 4 µg/L in groundwater results in 0.054% of children above a blood lead level of 10 µg/dL. Geometric mean blood lead = 2.152 µg/dL. This is below the blood lead goal as described in the 1994 OSWER Directive of no more than 5% of children exceeding 10 µg/dL blood lead.	PRG not calculated.

LEAD MODEL FOR WINDOWS Version 1.0

Model Version: 1.0 Build 264

User Name: CH2MHILL

Date: 10/23/08

Site Name: St. Louis Ordnance Plant, Former Hanley Area - St. Louis, Missouri

Operable Unit: SUBUNIT G

Run Mode: Site Risk Assessment

Soil/Dust Data

Values Based on Arithmetic Mean- Subunit G

The time step used in this model run: 1 - Every 4 Hours (6 times a day).

***** Air *****

Indoor Air Pb Concentration: 30.000 percent of outdoor.

Other Air Parameters:

Age	Time Outdoors (hours)	Ventilation Rate (m ³ /day)	Lung Absorption (%)	Outdoor Air Pb Conc (ug Pb/m ³)
.5-1	1.000	2.000	32.000	0.100
1-2	2.000	3.000	32.000	0.100
2-3	3.000	5.000	32.000	0.100
3-4	4.000	5.000	32.000	0.100
4-5	4.000	5.000	32.000	0.100
5-6	4.000	7.000	32.000	0.100
6-7	4.000	7.000	32.000	0.100

***** Diet *****

Age	Diet Intake(ug/day)
.5-1	2.260
1-2	1.960
2-3	2.130
3-4	2.040
4-5	1.950
5-6	2.050
6-7	2.220

***** Drinking Water *****

Water Consumption:

Age	Water (L/day)
.5-1	0.200
1-2	0.500
2-3	0.520
3-4	0.530
4-5	0.550
5-6	0.580
6-7	0.590

Drinking Water Concentration: 4.000 ug Pb/L

***** Soil & Dust *****

Multiple Source Analysis Used

Average multiple source concentration: 103.415 ug/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700
 Outdoor airborne lead to indoor household dust lead concentration: 100.000
 Use alternate indoor dust Pb sources? No

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
.5-1	133.450	103.415
1-2	133.450	103.415
2-3	133.450	103.415
3-4	133.450	103.415
4-5	133.450	103.415
5-6	133.450	103.415
6-7	133.450	103.415

***** Alternate Intake *****

Age	Alternate (ug Pb/day)
.5-1	0.000
1-2	0.000
2-3	0.000
3-4	0.000
4-5	0.000
5-6	0.000
6-7	0.000

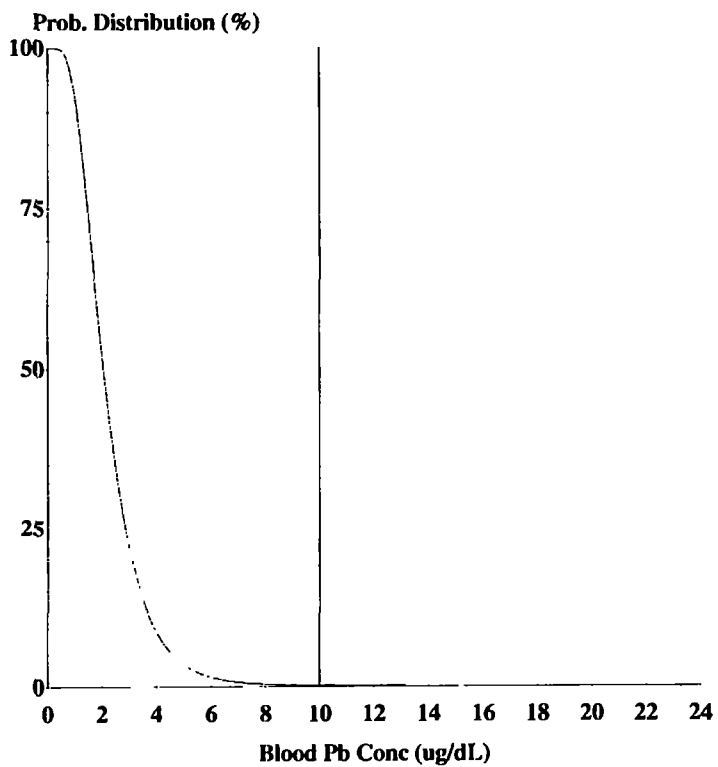
***** Maternal Contribution: Infant Model *****

Maternal Blood Concentration: 2.500 ug Pb/dL

 CALCULATED BLOOD LEAD AND LEAD UPTAKES:

Year	Air (ug/day)	Diet (ug/day)	Alternate (ug/day)	Water (ug/day)
.5-1	0.021	1.076	0.000	0.381
1-2	0.034	0.927	0.000	0.946
2-3	0.062	1.015	0.000	0.991
3-4	0.067	0.979	0.000	1.017
4-5	0.067	0.947	0.000	1.068
5-6	0.093	0.999	0.000	1.131
6-7	0.093	1.085	0.000	1.153

Year	Soil+Dust (ug/day)	Total (ug/day)	Blood (ug/dL)
.5-1	2.840	4.318	2.4
1-2	4.480	6.387	2.7
2-3	4.512	6.579	2.5
3-4	4.543	6.606	2.3
4-5	3.406	5.487	1.9
5-6	3.079	5.303	1.7
6-7	2.914	5.246	1.5



Cutoff = 10.000 ug/dl
Geo Mean = 2.152
GSD = 1.600
% Above = 0.054

Age Range = 0 to 84 months
Time Step = Every 4 Hours
Run Mode = Site Risk Assessment
Comment = SUBUNIT G

APPENDIX T

TABLE 11.13

RAGS D IEUBK Lead Worksheet

Child (Age 0 – 84 Months), Subsurface Soil (0-10 ft) – Exposure Unit L

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

1. Lead Screening Questions

Medium	Lead Concentration Used in Model Run		Basis for Lead Concentration Used For Model Run	Lead Screening Concentration		Basis for Lead Screening Level
	Value	Units		Value	Units	
Soil	136.873	mg/kg	Average Detected Value	400	mg/kg	Recommended Soil Screening Level
Water	4.0	µg/L	Model Default	15	µg/L	Recommended Drinking Water Action Level

2. Lead Model Questions

Question	Response for Residential Lead Model
What lead model (version and date) was used?	Lead Model for Windows, Version 1.0 Build 264
Where are the input values located in the risk assessment report?	Located in IEUBKwin OUTPUT (Attached as Appendix M, Tables 11.14 and 11.15)
What range of media concentrations were used for the model?	14.9-510 mg/kg
What statistics were used to represent the exposure concentration terms and where are the data on concentrations in the risk assessment that support use of these statistics?	Arithmetic Mean Concentration
Was soil sample taken from top 2 cm? If not, why?	No. Surface soil and subsurface data set was used to represent subsurface soil.
Was soil sample sieved? What size screen was used? If not sieved, provide rationale.	No – Soil samples were collected for multiple analyses.
What was the point of exposure/location?	St. Louis Ordnance Plant, Former Hanley Area - St. Louis, Missouri
Where are the output values located in the risk assessment report?	IEUBKwin OUTPUT (Attached as Appendix M, Tables 11.14 and 11.15)
Was the model run using default values only?	No – Assumed site-specific arithmetic mean concentration of lead in soil.
Was the default soil bioavailability used?	Yes – Default is 30%
Was the default soil ingestion rate used?	Yes – Default values for 7 age groups are 85, 135, 135, 100, 090, and 85 mg/day
If non-default values were used, where is the rationale for the values located in the risk assessment report?	Located in Section 7.3.3.

3. Final Result

Medium	Result	Comment/PRG 1
Subsurface Soil (0-10 ft)	Input value of 136.873 mg/kg in subsurface soil and 4 µg/L in groundwater results in 0.060% of children above a blood lead level of 10 µg/dL. Geometric mean blood lead = 2.184 µg/dL. This is below the blood lead goal as described in the 1994 OSWER Directive of no more than 5% of children exceeding 10 µg/dL blood lead.	PRG not calculated.

LEAD MODEL FOR WINDOWS Version 1.0

```
=====
Model Version: 1.0 Build 264
User Name: CH2MHILL
Date: 10/23/08
Site Name: St. Louis Ordnance Plant, Former Hanley Area - St. Louis, Missouri
Operable Unit: SUBUNIT L
Run Mode: Site Risk Assessment
-----
```

Soil/Dust Data

Values Based on Arithmetic Mean- Subunit L

```
=====
The time step used in this model run: 1 - Every 4 Hours (6 times a day).
```

***** Air *****

Indoor Air Pb Concentration: 30.000 percent of outdoor.
Other Air Parameters:

Age	Time Outdoors (hours)	Ventilation Rate (m ³ /day)	Lung Absorption (%)	Outdoor Air Pb Conc (ug Pb/m ³)
.5-1	1.000	2.000	32.000	0.100
1-2	2.000	3.000	32.000	0.100
2-3	3.000	5.000	32.000	0.100
3-4	4.000	5.000	32.000	0.100
4-5	4.000	5.000	32.000	0.100
5-6	4.000	7.000	32.000	0.100
6-7	4.000	7.000	32.000	0.100

***** Diet *****

Age	Diet Intake(ug/day)
-----	---------------------

.5-1	2.260
1-2	1.960
2-3	2.130
3-4	2.040
4-5	1.950
5-6	2.050
6-7	2.220

***** Drinking Water *****

Water Consumption:

Age	Water (L/day)
-----	---------------

.5-1	0.200
1-2	0.500
2-3	0.520
3-4	0.530
4-5	0.550
5-6	0.580
6-7	0.590

Drinking Water Concentration: 4.000 ug Pb/L

***** Soil & Dust *****

Multiple Source Analysis Used

Average multiple source concentration: 105.811 ug/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700
 Outdoor airborne lead to indoor household dust lead concentration: 100.000
 Use alternate indoor dust Pb sources? No

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
.5-1	136.873	105.811
1-2	136.873	105.811
2-3	136.873	105.811
3-4	136.873	105.811
4-5	136.873	105.811
5-6	136.873	105.811
6-7	136.873	105.811

***** Alternate Intake *****

Age	Alternate (ug Pb/day)
.5-1	0.000
1-2	0.000
2-3	0.000
3-4	0.000
4-5	0.000
5-6	0.000
6-7	0.000

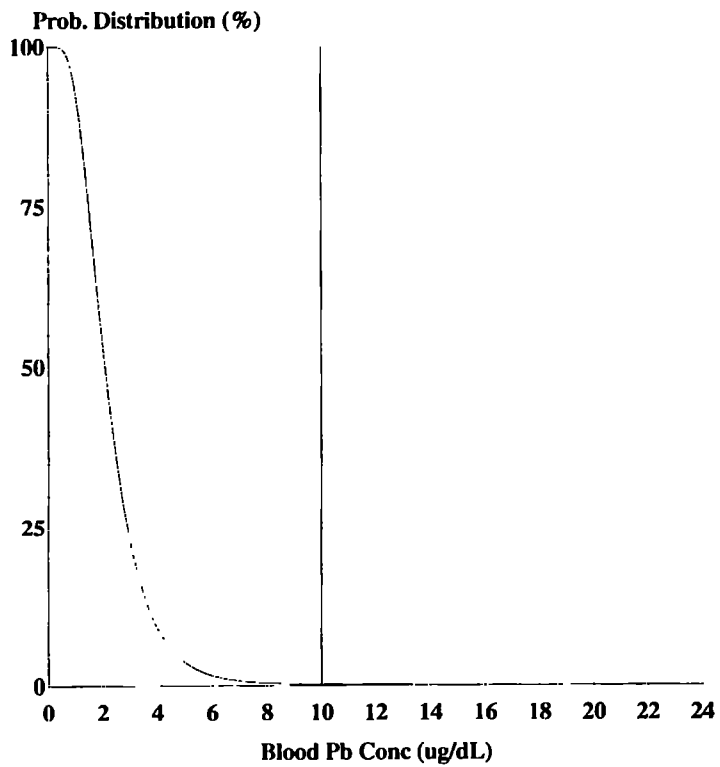
***** Maternal Contribution: Infant Model *****

Maternal Blood Concentration: 2.500 ug Pb/dL

CALCULATED BLOOD LEAD AND LEAD UPTAKES:

Year	Air (ug/day)	Diet (ug/day)	Alternate (ug/day)	Water (ug/day)
.5-1	0.021	1.075	0.000	0.381
1-2	0.034	0.926	0.000	0.945
2-3	0.062	1.014	0.000	0.990
3-4	0.067	0.978	0.000	1.016
4-5	0.067	0.946	0.000	1.067
5-6	0.093	0.999	0.000	1.131
6-7	0.093	1.085	0.000	1.153

Year	Soil+Dust (ug/day)	Total (ug/day)	Blood (ug/dL)
.5-1	2.907	4.384	2.4
1-2	4.585	6.491	2.7
2-3	4.619	6.685	2.5
3-4	4.651	6.712	2.4
4-5	3.487	5.568	2.0
5-6	3.153	5.376	1.7
6-7	2.985	5.316	1.5



Cutoff = 10.000 ug/dl
Geo Mean = 2.184
GSD = 1.600
% Above = 0.060

Age Range = 0 to 84 months
Time Step = Every 4 Hours
Run Mode = Site Risk Assessment
Comment = SUBUNIT L

APPENDIX U

TABLE 1.1

Summary of Analytes Exceeding Background Concentrations

On-Site Soil Data Collected from 0-2 feet Depth Interval - Sitewide Analysis

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Chemical Group	CAS	Analyte	Minimum Detected Concentration	Maximum Detected Concentration	Average Concentration	No. of Detection	No. of Samples	FOD	SL	Background	MaxDet Exceeds SL
PAHs	208-96-8	Acenaphthylene	0.00579	0.00579	0.00579	1	2	50%	570	0.0305	
PAHs	191-24-2	Benzo(g,h,i)perylene	0.044	0.3555	0.156346154	13	13	100%	4,200	0.478	
PAHs	85-01-8	Phenanthrene	0.0538	0.9221	0.313842857	14	17	82%	12,000	1.04	

Note:

Concentrations presented in mg/kg

PAH - Polycyclic Aromatic Hydrocarbon

Screening Level (SL)

SL is the lower value of the following:

MSSL = USEPA Region 6 Medium-Specific Screening Levels (MSSLs) for industrial outdoor worker. MSSLs adjusted downward by a factor of 10 to account for cumulative effects from multiple noncarcinogens acting on the same target organ.

SSL = USEPA Region 6 Soil Screening Levels (SSLs) for protection of migration to groundwater using a dilution-attenuation factor (DAF) of 20.

Acenaphthene was used as a surrogate for acenaphthylene.

Pyrene was used a surrogate for benzo(g,h,i)perylene.

Anthracene was used as a surrogate for phenanthrene.

APPENDIX U

TABLE 1.2

Summary of Analytes Exceeding Background Concentrations

On-Site Soil Data Collected from 0-10 feet Depth Interval - Sitewide Analysis

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

CAS	Chemical Group	Analyte	Minimum Detected Concentration	Maximum Detected Concentration	Average Concentration	No. of Detection	No. of Samples	FOD	SL	Background	MaxDet Exceeds SL
208-96-8	PAHs	Acenaphthylene	0.0022	0.009	0.004815	6	7	86%	570	0.0305	
191-24-2	PAHs	Benzo(g,h,i)perylene	0.0039	0.3555	0.11201379	29	29	100%	4,200	0.478	
85-01-8	PAHs	Phenanthrene	0.0049	0.9221	0.23121667	30	33	91%	12,000	1.04	

Note:

Concentrations presented in mg/kg

PAH - Polycyclic Aromatic Hydrocarbon

Screening Level (SL)

SL is the lower value of the following:

MSSL = USEPA Region 6 Medium-Specific Screening Levels (MSSLs) for industrial outdoor worker. MSSLs adjusted downward by a factor of 10 to account for cumulative effects from multiple noncarcinogens acting on the same target organ.

SSL = USEPA Region 6 Soil Screening Levels (SSLs) for protection of migration to groundwater using a dilution-attenuation factor (DAF) of 20.

Acenaphthene was used as a surrogate for acenaphthylene.

Pyrene was used as a surrogate for benzo(g,h,i)perylene.

Anthracene was used as a surrogate for phenanthrene.

APPENDIX U

TABLE 1.3

Summary of Analytes Exceeding Background Concentrations

On-Site Soil Data Collected from 0-10 feet Depth Interval - Exposure Unit A

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Chemical Group	CAS	Analyte	Minimum Detected Concentration	Maximum Detected Concentration	Average Concentration	No. of Detection	No. of Samples	FOD	SL	Background	Max Detect Exceeds SL?
Metals	7440-38-2	Arsenic	5.646396	8.92	6.7	5	9	55.56%	0.390	12.3	Yes
PAHs	208-96-8	Acenaphthylene	0.0022	0.0022	0.0022	1	1	100.00%	368	0.0305	
PAHs	56-55-3	Benzo(a)anthracene	0.0307	0.0801	0.055	2	3	66.67%	0.148	0.887	
PAHs	50-32-8	Benzo(a)pyrene	0.0295	0.0757	0.053	2	2	100.00%	0.015	0.735	Yes
PAHs	205-99-2	Benzo(b)fluoranthene	0.0467	0.1228	0.085	2	3	66.67%	0.148	0.626	
PAHs	191-24-2	Benzo(g,h,i)perylene	0.0258	0.0658	0.046	2	2	100.00%	231	0.478	
PAHs	53-70-3	Dibenz(a,h)anthracene	0.0048	0.0121	0.0085	2	2	100.00%	2	0.303	
PAHs	193-39-5	Indeno(1,2,3-cd)pyrene	0.0223	0.0581	0.040	2	2	100.00%	14	0.415	
PAHs	85-01-8	Phenanthrene	0.0213	0.0652	0.043	2	3	66.67%	2190	1.04	

Note:

Concentrations presented in mg/kg

PAH - Polycyclic Aromatic Hydrocarbon

Screening Level (SL)

SL is the lower value of the following:

MSSL = USEPA Region 6 Medium-Specific Screening Levels (MSSLs) for residential land use. MSSLs adjusted downward by a factor of 10 to account for cumulative effects from multiple noncarcinogens acting on the same target organ.

SSL = USEPA Region 6 Soil Screening Levels (SSLs) for protection of migration to groundwater using a dilution-attenuation factor (DAF) of 20.

Acenaphthene was used as a surrogate for acenaphthylene.

Pyrene was used a surrogate for benzo(g,h,i)perylene.

Anthracene was used as a surrogate for phenanthrene.

APPENDIX U

TABLE 1.4

Summary of Analytes Exceeding Background Concentrations

On-Site Soil Data Collected from 0-10 feet Depth Interval - Exposure Unit B

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Chemical Group	CAS	Analyte	Minimum Detected Concentration	Maximum Detected Concentration	Average Concentration	No. of Detection	No. of Samples	FOD	SL	Background	Max Detect Exceeds SL?
PAHs	208-96-8	Acenaphthylene	0.0037	0.0037	0.0037	1	1	100.00%	368	0.0305	Yes
PAHs	56-55-3	Benzo(a)anthracene	0.024	0.024	0.024	1	1	100.00%	0.148	0.887	
PAHs	50-32-8	Benzo(a)pyrene	0.0198	0.121	0.070	2	2	100.00%	0.015	0.735	
PAHs	205-99-2	Benzo(b)fluoranthene	0.0284	0.0284	0.028	1	1	100.00%	0.148	0.626	
PAHs	191-24-2	Benzo(g,h,i)perylene	0.0155	0.0155	0.016	1	1	100.00%	231	0.478	
PAHs	53-70-3	Dibenz(a,h)anthracene	0.003	0.003	0.0030	1	1	100.00%	2	0.303	
PAHs	193-39-5	Indeno(1,2,3-cd)pyrene	0.0148	0.0148	0.015	1	1	100.00%	14	0.415	
PAHs	85-01-8	Phenanthrene	0.0132	0.0132	0.013	1	1	100.00%	2190	1.04	

Note:

Concentrations presented in mg/kg

PAH - Polycyclic Aromatic Hydrocarbon

Screening Level (SL)

SL is the lower value of the following:

MSSL = USEPA Region 6 Medium-Specific Screening Levels (MSSLs) for residential land use. MSSLs adjusted downward by a factor of 10 to account for cumulative effects from multiple noncarcinogens acting on the same target organ.

SSL = USEPA Region 6 Soil Screening Levels (SSLs) for protection of migration to groundwater using a dilution-attenuation factor (DAF) of 20.

Acenaphthene was used as a surrogate for acenaphthylene.

Pyrene was used a surrogate for benzo(g,h,i)perylene.

Anthracene was used as a surrogate for phenanthrene.

APPENDIX U

TABLE 1.5

Summary of Analytes Exceeding Background Concentrations

On-Site Soil Data Collected from 0-10 feet Depth Interval - Exposure Unit C

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Chemical Group	CAS	Analyte	Minimum Detected Concentration	Maximum Detected Concentration	Average Concentration	No. of Detection	No. of Samples	FOD	SL	Background	Max Detect Exceeds SL?
Metals	7440-38-2	Arsenic	4	11.7	7.0	3	4	75.00%	0.390	12.3	Yes
PAHs	56-55-3	Benzo(a)anthracene	0.0214	0.0214	0.021	1	1	100.00%	0.148	0.887	Yes
PAHs	50-32-8	Benzo(a)pyrene	0.0197	0.0197	0.020	1	1	100.00%	0.015	0.735	
PAHs	205-99-2	Benzo(b)fluoranthene	0.0278	0.0278	0.028	1	1	100.00%	0.148	0.626	
PAHs	191-24-2	Benzo(g,h,i)perylene	0.0143	0.0143	0.014	1	1	100.00%	231	0.478	
PAHs	53-70-3	Dibenz(a,h)anthracene	0.003	0.003	0.0030	1	1	100.00%	2	0.303	
PAHs	193-39-5	Indeno(1,2,3-cd)pyrene	0.0131	0.0131	0.013	1	1	100.00%	14	0.415	
PAHs	85-01-8	Phenanthrene	0.0182	0.0182	0.018	1	1	100.00%	2,190	1.04	

Note:

Concentrations presented in mg/kg

PAH - Polycyclic Aromatic Hydrocarbon

Screening Level (SL)

SL is the lower value of the following:

MSSL = USEPA Region 6 Medium-Specific Screening Levels (MSSLs) for residential land use. MSSLs adjusted downward by a factor of 10 to account for cumulative effects from multiple noncarcinogens acting on the same target organ.

SSL = USEPA Region 6 Soil Screening Levels (SSLs) for protection of migration to groundwater using a dilution-attenuation factor (DAF) of 20.

Pyrene was used a surrogate for benzo(g,h,i)perylene.

Anthracene was used as a surrogate for phenanthrene.

APPENDIX U

TABLE 1.6

Summary of Analytes Exceeding Background Concentrations

On-Site Soil Data Collected from 0-10 feet Depth Interval - Exposure Unit D

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Chemical Group	CAS	Analyte	Minimum Detected Concentration	Maximum Detected Concentration	Average Concentration	No. of Detection	No. of Samples	FOD	SL	Background	Max Detect Exceeds SL?
Metals	7440-38-2	Arsenic	6.65	8.59	7.2	4	4	100.00%	0.390	12.3	Yes

Note:

Concentrations presented in mg/kg

PAH - Polycyclic Aromatic Hydrocarbon

Screening Level (SL)

SL is the lower value of the following:

MSSL = USEPA Region 6 Medium-Specific Screening Levels (MSSLs) for residential land use. MSSLs adjusted downward by a factor of 10 to account for cumulative effects from multiple noncarcinogens acting on the same target organ.

SSL = USEPA Region 6 Soil Screening Levels (SSLs) for protection of migration to groundwater using a dilution-attenuation factor (DAF) of 20.

APPENDIX U

TABLE 1.7

Summary of Analytes Exceeding Background Concentrations

On-Site Soil Data Collected from 0-10 feet Depth Interval - Exposure Unit E

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Chemical Group	CAS	Analyte	Minimum Detected Concentration	Maximum Detected Concentration	Average Concentration	No. of Detection	No. of Samples	FOD	SL	Background	Max Detect Exceeds SL?
PAHs	56-55-3	Benzo(a)anthracene	0.0545	0.0545	0.055	1	2	50.00%	0.148	0.887	Yes
PAHs	50-32-8	Benzo(a)pyrene	0.0485	0.0485	0.049	1	1	100.00%	0.015	0.735	
PAHs	205-99-2	Benzo(b)fluoranthene	0.0802	0.0802	0.080	1	2	50.00%	0.148	0.626	
PAHs	191-24-2	Benzo(g,h,i)perylene	0.0362	0.0362	0.036	1	1	100.00%	231	0.478	
PAHs	53-70-3	Dibenz(a,h)anthracene	0.0074	0.0074	0.0074	1	1	100.00%	2	0.303	
PAHs	193-39-5	Indeno(1,2,3-cd)pyrene	0.0313	0.0313	0.031	1	1	100.00%	14	0.415	
PAHs	85-01-8	Phenanthrene	0.0227	0.0227	0.023	1	2	50.00%	2,190	1.04	

Note:

Concentrations presented in mg/kg

PAH - Polycyclic Aromatic Hydrocarbon

Screening Level (SL)

SL is the lower value of the following:

MSSL = USEPA Region 6 Medium-Specific Screening Levels (MSSLs) for residential land use. MSSLs adjusted downward by a factor of 10 to account for cumulative effects from multiple noncarcinogens acting on the same target organ.

SSL = USEPA Region 6 Soil Screening Levels (SSLs) for protection of migration to groundwater using a dilution-attenuation factor (DAF) of 20.

Pyrene was used a surrogate for benzo(g,h,i)perylene.

Anthracene was used as a surrogate for phenanthrene.

APPENDIX U

TABLE 1.8

Summary of Analytes Exceeding Background Concentrations

On-Site Soil Data Collected from 0-10 feet Depth Interval - Exposure Unit F

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Chemical Group	CAS	Analyte	Minimum Detected Concentration	Maximum Detected Concentration	Average Concentration	No. of Detection	No. of Samples	FOD	SL	Background	Max Detect Exceeds SL?
PAHs	208-96-8	Acenaphthylene	0.00579	0.00579	0.0058	1	1	100.00%	368	0.0305	
PAHs	56-55-3	Benzo(a)anthracene	0.0374	0.201	0.10	3	4	75.00%	0.148	0.887	Yes
PAHs	50-32-8	Benzo(a)pyrene	0.0321	0.1428	0.086	4	4	100.00%	0.015	0.735	Yes
PAHs	205-99-2	Benzo(b)fluoranthene	0.0557	0.2461	0.13	4	5	80.00%	0.148	0.626	Yes
PAHs	191-24-2	Benzo(g,h,i)perylene	0.0264	0.1125	0.076	3	3	100.00%	231	0.478	
PAHs	53-70-3	Dibenz(a,h)anthracene	0.0051	0.0301	0.015	3	3	100.00%	2	0.303	
PAHs	193-39-5	Indeno(1,2,3-cd)pyrene	0.0233	0.1291	0.067	4	4	100.00%	14	0.415	
PAHs	85-01-8	Phenanthrene	0.0223	0.2965	0.13	4	4	100.00%	2,190	1.04	

Note:

Concentrations presented in mg/kg

PAH - Polycyclic Aromatic Hydrocarbon

Screening Level (SL)

SL is the lower value of the following:

MSSL = USEPA Region 6 Medium-Specific Screening Levels (MSSLs) for residential land use. MSSLs adjusted downward by a factor of 10 to account for cumulative effects from multiple noncarcinogens acting on the same target organ.

SSL = USEPA Region 6 Soil Screening Levels (SSLs) for protection of migration to groundwater using a dilution-attenuation factor (DAF) of 20.

Acenaphthene was used as a surrogate for acenaphthylene.

Pyrene was used as a surrogate for benzo(g,h,i)perylene.

Anthracene was used as a surrogate for phenanthrene.

APPENDIX U

TABLE 1.9

Summary of Analytes Exceeding Background Concentrations

On-Site Soil Data Collected from 0-10 feet Depth Interval - Exposure Unit G

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Chemical Group	CAS	Analyte	Minimum Detected Concentration	Maximum Detected Concentration	Average Concentration	No. of Detection	No. of Samples	FOD	SL	Background	Max Detect Exceeds SL?
Metals	7440-38-2	Arsenic	5.1	8.44	7.0	6	9	66.67%	0.390	12.3	Yes
PAHs	208-96-8	Acenaphthylene	0.009	0.009	0.0090	1	1	100.00%	368	0.0305	
PAHs	56-55-3	Benzo(a)anthracene	0.1113	0.7295	0.42	2	3	66.67%	0.148	0.887	Yes
PAHs	50-32-8	Benzo(a)pyrene	0.08	0.5053	0.29	2	2	100.00%	0.015	0.735	Yes
PAHs	191-24-2	Benzo(g,h,i)perylene	0.0523	0.3555	0.20	2	2	100.00%	231	0.478	
PAHs	53-70-3	Dibenz(a,h)anthracene	0.0114	0.0811	0.046	2	2	100.00%	2	0.303	
PAHs	193-39-5	Indeno(1,2,3-cd)pyrene	0.0462	0.3387	0.19	2	2	100.00%	14	0.415	
PAHs	85-01-8	Phenanthrene	0.164	0.8081	0.49	2	3	66.67%	2,190	1.04	

Note:

Concentrations presented in mg/kg

PAH - Polycyclic Aromatic Hydrocarbon

Screening Level (SL)

SL is the lower value of the following:

MSSL = USEPA Region 6 Medium-Specific Screening Levels (MSSLs) for residential land use. MSSLs adjusted downward by a factor of 10 to account for cumulative effects from multiple noncarcinogens acting on the same target organ.

SSL = USEPA Region 6 Soil Screening Levels (SSLs) for protection of migration to groundwater using a dilution-attenuation factor (DAF) of 20.

Acenaphthene was used as a surrogate for acenaphthylene.

Pyrene was used a surrogate for benzo(g,h,i)perylene.

Anthracene was used as a surrogate for phenanthrene.

APPENDIX U**TABLE 1.10**

Summary of Analytes Exceeding Background Concentrations

On-Site Soil Data Collected from 0-10 feet Depth Interval - Exposure Unit H

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Chemical Group	CAS	Analyte	Minimum Detected Concentration	Maximum Detected Concentration	Average Concentration	No. of Detection	No. of Samples	FOD	SL	Background	Max Detect Exceeds SL?
PAHs	56-55-3	Benzo(a)anthracene	0.2152	0.3252	0.25	3	3	100.00%	0.148	0.887	Yes
PAHs	50-32-8	Benzo(a)pyrene	0.0659	0.2641	0.15	5	5	100.00%	0.015	0.735	Yes
PAHs	205-99-2	Benzo(b)fluoranthene	0.104	0.4697	0.31	4	4	100.00%	0.148	0.626	Yes
PAHs	191-24-2	Benzo(g,h,i)perylene	0.1523	0.2008	0.17	3	3	100.00%	231	0.478	
PAHs	53-70-3	Dibenz(a,h)anthracene	0.0357	0.0411	0.038	3	3	100.00%	2	0.303	
PAHs	193-39-5	Indeno(1,2,3-cd)pyrene	0.1766	0.1779	0.18	3	3	100.00%	14	0.415	
PAHs	85-01-8	Phenanthrene	0.1529	0.4365	0.25	3	3	100.00%	2,190	1.04	

Note:

Concentrations presented in mg/kg

PAH - Polycyclic Aromatic Hydrocarbon

Screening Level (SL)

SL is the lower value of the following:

MSSL = USEPA Region 6 Medium-Specific Screening Levels (MSSLs) for residential land use. MSSLs adjusted downward by a factor of 10 to account for cumulative effects from multiple noncarcinogens acting on the same target organ.

SSL = USEPA Region 6 Soil Screening Levels (SSLs) for protection of migration to groundwater using a dilution-attenuation factor (DAF) of 20.

Pyrene was used a surrogate for benzo(g,h,i)perylene.

Anthracene was used as a surrogate for phenanthrene.

APPENDIX U

TABLE 1.11

Summary of Analytes Exceeding Background Concentrations

On-Site Soil Data Collected from 0-10 feet Depth Interval - Exposure Unit I

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Chemical Group	CAS	Analyte	Minimum Detected Concentration	Maximum Detected Concentration	Average Concentration	No. of Detection	No. of Samples	FOD	SL	Background	Max Detect Exceeds SL?
Metals	7440-38-2	Arsenic	7.009738	8.952692	8.0	2	6	33.33%	0.390	12.3	Yes
PAHs	56-55-3	Benzo(a)anthracene	0.0058	0.0761	0.041	2	2	100.00%	0.148	0.887	Yes
PAHs	50-32-8	Benzo(a)pyrene	0.0039	0.0507	0.027	2	2	100.00%	0.015	0.735	
PAHs	205-99-2	Benzo(b)fluoranthene	0.0079	0.1117	0.060	2	2	100.00%	0.148	0.626	
PAHs	191-24-2	Benzo(g,h,i)perylene	0.0039	0.0481	0.026	2	2	100.00%	231	0.478	
PAHs	53-70-3	Dibenz(a,h)anthracene	0.0099	0.0099	0.0099	1	1	100.00%	2	0.303	
PAHs	193-39-5	Indeno(1,2,3-cd)pyrene	0.0034	0.0423	0.023	2	2	100.00%	14	0.415	
PAHs	85-01-8	Phenanthrene	0.0049	0.0298	0.017	2	2	100.00%	2,190	1.04	

Note:

Concentrations presented in mg/kg

PAH - Polycyclic Aromatic Hydrocarbon

Screening Level (SL)

SL is the lower value of the following:

MSSL = USEPA Region 6 Medium-Specific Screening Levels (MSSLs) for residential land use. MSSLs adjusted downward by a factor of 10 to account for cumulative effects from multiple noncarcinogens acting on the same target organ.

SSL = USEPA Region 6 Soil Screening Levels (SSLs) for protection of migration to groundwater using a dilution-attenuation factor (DAF) of 20.

Pyrene was used a surrogate for benzo(g,h,i)perylene.

Anthracene was used as a surrogate for phenanthrene.

APPENDIX U

TABLE 1.12

Summary of Analytes Exceeding Background Concentrations

On-Site Soil Data Collected from 0-10 feet Depth Interval - Exposure Unit J

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Chemical Group	CAS	Analyte	Minimum Detected Concentration	Maximum Detected Concentration	Average Concentration	No. of Detection	No. of Samples	FOD	SL	Background	Max Detect Exceeds SL?
PAHs	56-55-3	Benzo(a)anthracene	0.059	0.5515	0.28	7	7	100.00%	0.148	0.887	Yes
PAHs	50-32-8	Benzo(a)pyrene	0.0472	0.4343	0.20	11	11	100.00%	0.015	0.735	Yes
PAHs	191-24-2	Benzo(g,h,i)perylene	0.044	0.3388	0.15	9	9	100.00%	231	0.478	
PAHs	53-70-3	Dibenz(a,h)anthracene	0.0229	0.0693	0.039	7	7	100.00%	2	0.303	
PAHs	193-39-5	Indeno(1,2,3-cd)pyrene	0.0483	0.3144	0.15	8	8	100.00%	14	0.415	
PAHs	85-01-8	Phenanthrene	0.0538	0.9221	0.40	7	7	100.00%	2,190	1.04	

Note:

Concentrations presented in mg/kg

PAH - Polycyclic Aromatic Hydrocarbon

Screening Level (SL)

SL is the lower value of the following:

MSSL = USEPA Region 6 Medium-Specific Screening Levels (MSSLs) for residential land use. MSSLs adjusted downward by a factor of 10 to account for cumulative effects from multiple noncarcinogens acting on the same target organ.

SSL = USEPA Region 6 Soil Screening Levels (SSLs) for protection of migration to groundwater using a dilution-attenuation factor (DAF) of 20.

Pyrene was used a surrogate for benzo(g,h,i)perylene.

Anthracene was used as a surrogate for phenanthrene.

APPENDIX U

TABLE 1.13

Summary of Analytes Exceeding Background Concentrations

On-Site Soil Data Collected from 0-10 feet Depth Interval - Exposure Unit K

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Chemical Group	CAS	Analyte	Minimum Detected Concentration	Maximum Detected Concentration	Average Concentration	No. of Detection	No. of Samples	FOD	SL	Background	Max Detect Exceeds SL?
Metals	7440-38-2	Arsenic	4.93	7.24647	6.3	7	9	77.78%	0.390	12.3	Yes
PAHs	208-96-8	Acenaphthylene	0.0039	0.0043	0.0041	2	2	100.00%	368	0.0305	
PAHs	56-55-3	Benzo(a)anthracene	0.0488	0.29	0.15	5	5	100.00%	0.148	0.887	Yes
PAHs	50-32-8	Benzo(a)pyrene	0.0438	0.1878	0.10	5	5	100.00%	0.015	0.735	Yes
PAHs	205-99-2	Benzo(b)fluoranthene	0.0773	0.48	0.24	5	5	100.00%	0.148	0.626	Yes
PAHs	191-24-2	Benzo(g,h,i)perylene	0.035	0.1538	0.081	4	4	100.00%	231	0.478	
PAHs	53-70-3	Dibenz(a,h)anthracene	0.0066	0.032	0.017	4	4	100.00%	2	0.303	
PAHs	193-39-5	Indeno(1,2,3-cd)pyrene	0.0327	0.1488	0.074	4	4	100.00%	14	0.415	
PAHs	85-01-8	Phenanthrene	0.04	0.6	0.21	5	5	100.00%	2,190	1.04	

Note:

Concentrations presented in mg/kg

PAH - Polycyclic Aromatic Hydrocarbon

Screening Level (SL)

SL is the lower value of the following:

MSSL = USEPA Region 6 Medium-Specific Screening Levels (MSSLs) for residential land use. MSSLs adjusted downward by a factor of 10 to account for cumulative effects from multiple noncarcinogens acting on the same target organ.

SSL = USEPA Region 6 Soil Screening Levels (SSLs) for protection of migration to groundwater using a dilution-attenuation factor (DAF) of 20.

Acenaphthene was used as a surrogate for acenaphthylene.

Pyrene was used as a surrogate for benzo(g,h,i)perylene.

Anthracene was used as a surrogate for phenanthrene.

APPENDIX U

TABLE 1.14

Summary of Analytes Exceeding Background Concentrations

On-Site Soil Data Collected from 0-10 feet Depth Interval - Exposure Unit L

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Chemical Group	CAS	Analyte	Minimum Detected Concentration	Maximum Detected Concentration	Average Concentration	No. of Detection	No. of Samples	FOD	SL	Background	Max Detect Exceeds SL?
Metals	7440-38-2	Arsenic	4.38	10.3	8.2	4	6	66.67%	0.390	12.3	Yes
PAHs	56-55-3	Benzo(a)anthracene	0.505	0.505	0.51	1	1	100.00%	0.148	0.887	Yes
PAHs	50-32-8	Benzo(a)pyrene	0.475	0.475	0.48	1	1	100.00%	0.015	0.735	Yes
PAHs	205-99-2	Benzo(b)fluoranthene	0.604	0.604	0.60	1	2	50.00%	0.148	0.626	Yes
PAHs	191-24-2	Benzo(g,h,i)perylene	0.242	0.242	0.24	1	1	100.00%	231	0.478	
PAHs	53-70-3	Dibenz(a,h)anthracene	0.0652	0.0652	0.065	1	1	100.00%	2	0.303	
PAHs	193-39-5	Indeno(1,2,3-cd)pyrene	0.211	0.211	0.21	1	1	100.00%	14	0.415	
PAHs	85-01-8	Phenanthrene	0.13	0.527	0.33	2	2	100.00%	2,190	1.04	

Note:

Concentrations presented in mg/kg

PAH - Polycyclic Aromatic Hydrocarbon

Screening Level (SL)

SL is the lower value of the following:

MSSL = USEPA Region 6 Medium-Specific Screening Levels (MSSLs) for residential land use. MSSLs adjusted downward by a factor of 10 to account for cumulative effects from multiple noncarcinogens acting on the same target organ.

SSL = USEPA Region 6 Soil Screening Levels (SSLs) for protection of migration to groundwater using a dilution-attenuation factor (DAF) of 20.

Pyrene was used a surrogate for benzo(g,h,i)perylene.

Anthracene was used as a surrogate for phenanthrene.

APPENDIX U

TABLE 2

Summary of Exposure Point Concentrations for COPCs Exceeding Background Concentrations

Exposure Units A through L

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Exposure Unit	Variable	Number of Detected Values	Number of Nondetected Values	% Nondetected Values	Minimum	Maximum	Mean	Median	Method	UCL	EPC	Max Used?
A	Arsenic	5	4	44.44%	5.646	8.92	6.732	6.3	95% KM (Percentile Bootstrap) UCL	7.014	7.014	No
	Benzo(a)pyrene	2	0	0.00%	0.0295	0.0757	0.053	0.053	NA	NA	0.0757	Yes ²
B	Benzo(a)pyrene	2	0	0.00%	0.0198	0.121	0.070	0.070	NA	NA	0.121	Yes ²
C	Arsenic	3	1	25.00%	4	11.7	7.034048	5.402	NA	NA	11.7	Yes ²
	Benzo(a)pyrene	1	0	0.00%	0.0197	0.0197	0.0197	0.0197	NA	NA	0.0197	Yes ²
D	Arsenic	4	0	0.00%	6.65	8.59	7.245	6.695	NA	NA	8.59	Yes ²
E	Benzo(a)pyrene	1	0	0.00%	0.0485	0.0485	0.0485	0.0485	NA	NA	0.0485	Yes ²
F	Benzo(a)anthracene	3	1	25.00%	0.0374	0.201	0.103833	0.0731	NA	NA	0.201	Yes ²
	Benzo(a)pyrene	4	0	0.00%	0.0321	0.1428	0.08585	0.08425	NA	NA	0.1428	Yes ²
	Benzo(b)fluoranthene	4	1	20.00%	0.0577	0.246	0.132	0.112	95% KM (t) UCL	0.2	0.2	No
G	Arsenic	6	3	33.33%	5.1	8.44	7.018	7.046	95% KM (Percentile Bootstrap) UCL	7.438	7.438	No
	Benzo(a)anthracene	2	1	33.33%	0.1113	0.7295	0.4204	0.4204	NA	NA	0.7295	Yes ²
	Benzo(a)pyrene	2	0	0.00%	0.08	0.5053	0.29265	0.29265	NA	NA	0.5053	Yes ²
H	Benzo(a)anthracene	3	0	0.00%	0.2152	0.3252	0.2536	0.2204	NA	NA	0.3252	Yes ²
	Benzo(a)pyrene	5	0	0.00%	0.0659	0.264	0.151	0.165	Use 95% Student's-t UCL	0.226	0.226	No
	Benzo(b)fluoranthene	4	0	0.00%	0.104	0.4697	0.30905	0.33125	NA	NA	0.4697	Yes ²
I	Arsenic	2	4	66.67%	7.01	8.953	7.981	7.981	95% KM (t) UCL	8.176	8.176	No
	Benzo(a)pyrene	2	0	0.00%	0.0039	0.0507	0.0273	0.0273	NA	NA	0.0507	Yes ²
J	Benzo(a)anthracene	7	0	0.00%	0.059	0.552	0.279	0.232	Use 95% Student's-t UCL	0.428	0.428	No
	Benzo(a)pyrene	11	0	0.00%	0.0472	0.434	0.196	0.169	Use 95% Student's-t UCL	0.265	0.265	No

APPENDIX U

TABLE 2

Summary of Exposure Point Concentrations for COPCs Exceeding Background Concentrations

Exposure Units A through L

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Exposure Unit	Variable	Number of Detected Values	Number of Nondetected Values	% Nondetected Values	Minimum	Maximum	Mean	Median	Method	UCL	EPC	Max Used?
K	Arsenic	7	2	22.22%	4.93	7.246	6.328	6.67	95% KM (Percentile Bootstrap) UCL	6.631	6.631	No
	Benzo(a)anthracene	5	0	0.00%	0.0488	0.29	0.152	0.14	Use 95% Student's-t UCL	0.246	0.246	No
	Benzo(a)pyrene	5	0	0.00%	0.0438	0.188	0.105	0.109	Use 95% Student's-t UCL	0.158	0.158	No
	Benzo(b)fluoranthene	5	0	0.00%	0.0773	0.48	0.239	0.192	Use 95% Student's-t UCL	0.397	0.397	No
L	Arsenic	4	2	33.33%	4.38	10.3	8.19	9.04	95% KM (Percentile Bootstrap) UCL	10.05	10.05	No
	Benzo(a)anthracene	1	0	0.00%	0.505	0.505	0.505	0.505	NA	NA	0.505	Yes ²
	Benzo(a)pyrene	1	0	0.00%	0.475	0.475	0.475	0.475	NA	NA	0.475	Yes ²
	Benzo(b)fluoranthene	1	1	50.00%	0.604	0.604	0.604	0.604	NA	NA	0.604	Yes ²

Notes:

¹ Maximum detected concentration was used because the calculated UCL exceeds the maximum detected concentration

² Maximum detected concentration was used because of the small number of samples.

UCL = Upper Confidence Limit

EPC = Exposure Point Concentration

NA = Not applicable or not available

Units are milligram/kilogram

APPENDIX U

TABLE 3.1

Residential Adult - COPCs in Soil (0-10 ft) Exceeding Background Concentrations - Exposure Unit A

Potential Excess L

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

COPC	WOE ^a	SF _o (mg/kg-day) ⁻¹	SF _d (mg/kg-day) ⁻¹	URF (ug/m ³) ⁻¹	Soil EPC (mg/kg)	ABS _d	ABS _{gi}	Ingestion		Dermal		Inhalation		Total ELCR
								CDI (mg/kg-day)	ELCR	DAD (mg/kg-day)	ELCR	DAC (mg/m ³)	ELCR	
Arsenic	A	1.5E+00	1.5E+00	4.30E-03	7.01E+00	3.0E-02	9.5E-01	1.1E-05	2E-05	1.0E-06	2E-06	2.1E-09	9E-09	2E-05
Benzo(a)pyrene	B2	7.3E+00	7.3E+00	1.10E-03	7.57E-02	1.3E-01	1.0E+00	1.2E-07	9E-07	4.9E-08	4E-07	2.3E-11	3E-11	1E-06
ELCR Subtotals									2E-05		2E-06		9E-09	
Estimated Total Risk =														2E-05

^aCancer WOE Classifications:

Group A: Human carcinogen

Group B (B1, B2): Probable human carcinogen

Group C: Possible human carcinogen

Group D: Not classifiable

ABS_d = dermal absorption factor

ABS_{gi} = gastrointestinal absorption factor

CDI = chronic daily intake

DAC = daily average concentration

DAD = dermally absorbed dose

ELCR = excess lifetime cancer risk

EPC = exposure point concentration

mg/kg-day = milligrams per kilogram per day

mg/m³ = milligrams per cubic meter

SF_d = dermal slope factor

SF_o = oral slope factor

ug/m³ = microgram per cubic meter

URF = Inhalation unit risk factor

WOE = weight of evidence

APPENDIX U

TABLE 3.2

Residential Adult - COPCs in Soil (0-10 ft) Exceeding Background Concentrations - Exposure Unit A
Potential Noncarcinogenic Hazard Index - Adult Resident RME Scenario
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

COPC	RfD _o (mg/kg-day)	RfD _d (mg/kg-day)	RfC (mg/m ³)	Soil EPC (mg/kg)	ABS _g	ABS _d	RfDo Target Organ	RfC Target Organ	Ingestion		Dermal		Inhalation		Total HI
									CDI (mg/kg-day)	HQ	DAD (mg/kg-day)	HQ	DAC (mg/m ³)	HQ	
Arsenic	3.0E-04	3.0E-04	3.0E-05	7.01E+00	3.0E-02	9.5E-01	skin	developmental, cardiovascular system, nervous system	9.6E-06	3.2E-02	1.2E-06	3.8E-03	4.9E-09	1.6E-04	3.6E-02
Benzo(a)pyrene	NA	NA	NA	7.57E-02	1.3E-01	1.0E+00			1.0E-07	NA	NA	NA	5.3E-11	NA	NA
Subtotal Hazard Indices										3.2E-02		3.8E-03		1.6E-04	
														Total HI =	3.6E-02

ABS_d = dermal absorption factor
ABS_g = gastrointestinal absorption factor
CDI = chronic daily intake
DAC = daily average concentration
DAD = dermally absorbed dose
EPC = exposure point concentration
HI = Hazard Index
HQ = Hazard Quotient
mg/kg-day = milligrams per kilogram per day
mg/m³ = milligrams per cubic meter
RfC = reference concentration
RfD_d = dermal reference dose
RfD_o = oral reference dose

Total Skin: 3.6E-02
Total Developmental: 1.6E-04
Total Cardiovascular: 1.6E-04
Total Nervous System: 1.6E-04

APPENDIX U

TABLE 3.3

Residential Child - COPCs in Soil (0-10 ft) Exceeding Background Concentrations - Exposure Unit A

Potential Noncarcinogenic Hazard Index - Child Resident RME Scenario

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

COPC	RfD _o (mg/kg-day)	RfD _d (mg/kg-day)	RfC (mg/m ³)	Soil EPC (mg/kg)	ABS _d	ABS _g	RfDo Target Organ	RfC Target Organ	Ingestion		Dermal		Inhalation		Total HI
									CDI (mg/kg-day)	HQ	DAD (mg/kg-day)	HQ	DAC (mg/m ³)	HQ	
Arsenic	3.0E-04	3.0E-04	3.0E-05	7.01E+00	0.030	9.5E-01	skin	developmental, cardiovascular system, nervous system	9.0E-05	3.0E-01	7.5E-06	2.5E-02	4.9E-09	1.6E-04	3.2E-01
Benzo(a)pyrene	NA	NA	NA	7.57E-02	0.130	1.0E+00			9.7E-07	NA	NA	NA	5.3E-11	NA	NA
Subtotal Hazard Indices										3.0E-01		2.5E-02		1.6E-04	
Total HI =														3.2E-01	

ABS_d = dermal absorption factor

ABS_g = gastrointestinal absorption factor

CDI = chronic daily intake

DAC = daily average concentration

DAD = dermally absorbed dose

EPC = exposure point concentration

HI = Hazard Index

HQ = Hazard Quotient

mg/kg-day = milligrams per kilogram per day

mg/m³ = milligrams per cubic meter

RfC = reference concentration

RfD_d = dermal reference dose

RfD_o = oral reference dose

Total Skin:

3.2E-01

Total Developmental:

1.6E-04

Total Cardiovascular:

1.6E-04

Total Nervous System:

1.6E-04

APPENDIX U

TABLE 3.4

Residential Adult - COPCs in Soil (0-10 ft) Exceeding Background Concentrations - Exposure Unit B
Potential Excess Lifetime Cancer Risk - Adult/Child (Age-Adjusted) Resident RME Scenario
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

COPC	WOE ^a	SF _o (mg/kg-day) ⁻¹	SF _d (mg/kg-day) ⁻¹	URF (μg/m ³) ⁻¹	Soil EPC (mg/kg)	ABS _d	ABS _{gi}	Ingestion		Dermal		Inhalation		Total ELCR
								CDI (mg/kg-day)	ELCR	DAD (mg/kg-day)	ELCR	DAC (mg/m ³)	ELCR	
Benzo(a)pyrene	B2	7.3E+00	7.3E+00	1.10E-03	1.21E-01	1.3E-01	1.0E+00	1.9E-07	1E-06	7.8E-08	6E-07	3.7E-11	4E-11	2E-06
ELCR Subtotals									1E-06		6E-07		4E-11	
													Estimated Total Risk =	2E-06

^aCancer WOE Classifications:

- Group A: Human carcinogen
- Group B (B1, B2): Probable human carcinogen
- Group C: Possible human carcinogen
- Group D: Not classifiable

ABS_d = dermal absorption factor

ABS_{gi} = gastrointestinal absorption factor

CDI = chronic daily intake

DAC = daily average concentration

DAD = dermally absorbed dose

ELCR = excess lifetime cancer risk

EPC = exposure point concentration

mg/kg-day = milligrams per kilogram per day

mg/m³ = milligrams per cubic meter

SF_d = dermal slope factor

SF_o = oral slope factor

μg/m³ = microgram per cubic meter

URF = Inhalation unit risk factor

WOE = weight of evidence

APPENDIX U

TABLE 3.5

Residential Adult - COPCs in Soil (0-10 ft) Exceeding Background Concentrations - Exposure Unit B
 Potential Noncarcinogenic Hazard Index - Adult Resident RME Scenario
 St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

COPC	RfD _o (mg/kg-day)	RfD _d (mg/kg-day)	RfC (mg/m ³)	Soil EPC (mg/kg)	ABS _g	ABS _d	RfDo Target Organ	RfC Target Organ	Ingestion		Dermal		Inhalation		Total HI
									CDI (mg/kg-day)	HQ	DAD (mg/kg-day)	HQ	DAC (mg/m ³)	HQ	
Benzo(a)pyrene	NA	NA	NA	1.21E-01	1.3E-01	1.0E+00			1.7E-07	NA	NA	NA	8.5E-11	NA	NA
Subtotal Hazard Indices										NA		NA		NA	
													Total HI =		NA

ABS_d = dermal absorption factor

ABS_g = gastrointestinal absorption factor

CDI = chronic daily intake

DAC = daily average concentration

DAD = dermally absorbed dose

EPC = exposure point concentration

HI = Hazard Index

HQ = Hazard Quotient

mg/kg-day = milligrams per kilogram per day

mg/m³ = milligrams per cubic meter

RfC = reference concentration

RfD_d = dermal reference dose

RfD_o = oral reference dose

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TABLE 3.6

Residential Child - COPCs in Soil (0-10 ft) Exceeding Background Concentrations - Exposure Unit B

Potential Noncarcinogenic Hazard Index - Child Resident RME Scenario

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

COPC	Ingestion										Dermal		Inhalation		Total HI
	RfD _o	RfD _d	RfC	Soil EPC	ABS _d	ABS _g	RfDo Target	RfC Target	CDI	HQ	DAD	HQ	DAC		
	(mg/kg-day)	(mg/kg-day)	(mg/m ³)	(mg/kg)			Organ	Organ	(mg/kg-day)		(mg/kg-day)		(mg/m ³)		
Benzo(a)pyrene	NA	NA	NA	1.21E-01	0.130	1.0E+00			1.5E-06	NA	NA	NA	8.5E-11	NA	NA
Subtotal Hazard Indices										NA		NA		NA	
Total HI =														NA	

ABS_d = dermal absorption factor

ABS_g = gastrointestinal absorption factor

CDI = chronic daily intake

DAC = daily average concentration

DAD = dermally absorbed dose

EPC = exposure point concentration

HI = Hazard Index

HQ = Hazard Quotient

mg/kg-day = milligrams per kilogram per day

mg/m³ = milligrams per cubic meter

RfC = reference concentration

RfD_d = dermal reference dose

RfD_o = oral reference dose

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TABLE 3.7

Residential Adult - COPCs in Soil (0-10 ft) Exceeding Background Concentrations - Exposure Unit C

Potential Excess Lifetime Cancer Risk - Adult/Child (Age-Adjusted) Resident RME Scenario

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

COPC	WOE ^a	SF _o (mg/kg-day) ⁻¹	SF _d (mg/kg-day) ⁻¹	URF (μg/m ³) ⁻¹	Soil EPC (mg/kg)	ABS _d	ABS _{gi}	Ingestion		Dermal		Inhalation		Total ELCR
								CDI (mg/kg-day)	ELCR	DAD (mg/kg-day)	ELCR	DAC (mg/m ³)	ELCR	
Arsenic	A	1.5E+00	1.5E+00	4.30E-03	1.17E+01	3.0E-02	9.5E-01	1.8E-05	3E-05	1.7E-06	3E-06	3.5E-09	2E-08	3E-05
Benzo(a)pyrene	B2	7.3E+00	7.3E+00	1.10E-03	1.97E-02	1.3E-01	1.0E+00	3.1E-08	2E-07	1.3E-08	9E-08	6.0E-12	7E-12	3E-07
ELCR Subtotals									3E-05		3E-06		2E-08	
Estimated Total Risk =														3E-05

^aCancer WOE Classifications:

Group A: Human carcinogen

Group B (B1, B2): Probable human carcinogen

Group C: Possible human carcinogen

Group D: Not classifiable

ABS_d = dermal absorption factor

ABS_{gi} = gastrointestinal absorption factor

CDI = chronic daily intake

DAC = daily average concentration

DAD = dermally absorbed dose

ELCR = excess lifetime cancer risk

EPC = exposure point concentration

mg/kg-day = milligrams per kilogram per day

mg/m³ = milligrams per cubic meter

SF_d = dermal slope factor

SF_o = oral slope factor

μg/m³ = microgram per cubic meter

URF = Inhalation unit risk factor

WOE = weight of evidence

APPENDIX U

TABLE 3.8

Residential Adult - COPCs in Soil (0-10 ft) Exceeding Background Concentrations - Exposure Unit C

Potential Noncarcinogenic Hazard Index - Adult Resident RME Scenario

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

COPC	RfD _o (mg/kg-day)	RfD _d (mg/kg-day)	RfC (mg/m ³)	Soil EPC (mg/kg)	ABS _g	ABS _d	RfDo Target Organ	RfC Target Organ	Ingestion		Dermal		Inhalation		Total HI
									CDI (mg/kg-day)	HQ	DAD (mg/kg-day)	HQ	DAC (mg/m ³)	HQ	
Arsenic	3.0E-04	3.0E-04	3.0E-05	1.17E+01	3.0E-02	9.5E-01	skin	developmental, cardiovascular system, nervous system	1.6E-05	5.3E-02	1.9E-06	6.4E-03	8.2E-09	2.7E-04	6.0E-02
Benzo(a)pyrene	NA	NA	NA	1.97E-02	1.3E-01	1.0E+00			2.7E-08	NA	NA	NA	1.4E-11	NA	NA
Subtotal Hazard Indices										5.3E-02		6.4E-03		2.7E-04	
														Total HI =	6.0E-02

ABS_d = dermal absorption factor

ABS_g = gastrointestinal absorption factor

CDI = chronic daily intake

DAC = daily average concentration

DAD = dermally absorbed dose

EPC = exposure point concentration

HI = Hazard Index

HQ = Hazard Quotient

mg/kg-day = milligrams per kilogram per day

mg/m³ = milligrams per cubic meter

RfC = reference concentration

RfD_d = dermal reference dose

RfD_o = oral reference dose

Total Skin:	6.0E-02
Total Developmental:	2.7E-04
Total Cardiovascular:	2.7E-04
Total Nervous System:	2.7E-04

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TABLE 3.9

Residential Child - COPCs in Soil (0-10 ft) Exceeding Background Concentrations - Exposure Unit C
Potential Noncarcinogenic Hazard Index - Child Resident RME Scenario
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

COPC	RfD _o (mg/kg-day)	RfD _d (mg/kg-day)	RfC (mg/m ³)	Soil EPC (mg/kg)	ABS _d	ABS _{gi}	RfDo Target Organ	RfC Target Organ	Ingestion		Dermal		Inhalation		Total HI
									CDI (mg/kg-day)	HQ	DAD (mg/kg-day)	HQ	DAC (mg/m ³)	HQ	
Arsenic	3.0E-04	3.0E-04	3.0E-05	1.17E+01	0.030	9.5E-01	skin	developmental, cardiovascular system, nervous system	1.5E-04	5.0E-01	1.3E-05	4.2E-02	8.2E-09	2.7E-04	5.4E-01
Benzo(a)pyrene	NA	NA	NA	1.97E-02	0.130	1.0E+00			2.5E-07	NA	NA	NA	1.4E-11	NA	NA
Subtotal Hazard Indices										5.0E-01		4.2E-02		2.7E-04	
														Total HI =	5.4E-01

ABS_d = dermal absorption factor

ABS_{gi} = gastrointestinal absorption factor

CDI = chronic daily intake

DAC = daily average concentration

DAD = dermally absorbed dose

EPC = exposure point concentration

HI = Hazard Index

HQ = Hazard Quotient

mg/kg-day = milligrams per kilogram per day

mg/m³ = milligrams per cubic meter

RfC = reference concentration

RfD_d = dermal reference dose

RfD_o = oral reference dose

Total Skin:	5.4E-01
Total Developmental:	2.7E-04
Total Cardiovascular:	2.7E-04
Total Nervous System:	2.7E-04

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TABLE 3.10

Residential Adult - COPCs in Soil (0-10 ft) Exceeding Background Concentrations - Exposure Unit D
Potential Excess Lifetime Cancer Risk - Adult/Child (Age-Adjusted) Resident RME Scenario
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

COPC	WOE ^a	SF _o		URF	Soil EPC	ABS _d	ABS _{gi}	Ingestion		Dermal		Inhalation		Total ELCR
		(mg/kg-day) ⁻¹	(mg/kg-day) ⁻¹					CDI	ELCR	DAD	ELCR	DAC	ELCR	
Arsenic	A	1.5E+00	1.5E+00	4.30E-03	8.59E+00	3.0E-02	9.5E-01	1.3E-05	2E-05	1.3E-06	2E-06	2.6E-09	1E-08	2E-05
ELCR Subtotals									2E-05		2E-06		1E-08	
Estimated Total Risk =													2E-05	

^aCancer WOE Classifications:

- Group A: Human carcinogen
- Group B (B1, B2): Probable human carcinogen
- Group C: Possible human carcinogen
- Group D: Not classifiable

ABS_d = dermal absorption factor

ABS_{gi} = gastrointestinal absorption factor

CDI = chronic daily intake

DAC = daily average concentration

DAD = dermally absorbed dose

ELCR = excess lifetime cancer risk

EPC = exposure point concentration

mg/kg-day = milligrams per kilogram per day

mg/m³ = milligrams per cubic meter

SF_d = dermal slope factor

SF_o = oral slope factor

μg/m³ = microgram per cubic meter

URF = Inhalation unit risk factor

WOE = weight of evidence

APPENDIX U

TABLE 3.11

Residential Adult - COPCs in Soil (0-10 ft) Exceeding Background Concentrations - Exposure Unit D
 Potential Noncarcinogenic Hazard Index - Adult Resident RME Scenario
 St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

COPC	RfD _o (mg/kg-day)	RfD _d (mg/kg-day)	RfC (mg/m ³)	Soil EPC (mg/kg)	ABS _d	ABS _{gi}	RfDo Target Organ	RfC Target Organ	Ingestion		Dermal		Inhalation		Total HI
									CDI (mg/kg-day)	HQ	DAD (mg/kg-day)	HQ	DAC (mg/m ³)	HQ	
Arsenic	3.0E-04	3.0E-04	3.0E-05	8.59E+00	3.0E-02	9.5E-01	skin	developmental, cardiovascular system, nervous system	1.2E-05	3.9E-02	1.4E-06	4.7E-03	6.1E-09	2.0E-04	4.4E-02
Subtotal Hazard Indices										3.9E-02		4.7E-03		2.0E-04	
														Total HI =	4.4E-02

ABS_d = dermal absorption factor

ABS_{gi} = gastrointestinal absorption factor

CDI = chronic daily intake

DAC = daily average concentration

DAD = dermally absorbed dose

EPC = exposure point concentration

HI = Hazard Index

HQ = Hazard Quotient

mg/kg-day = milligrams per kilogram per day

mg/m³ = milligrams per cubic meter

RfC = reference concentration

RfD_d = dermal reference dose

RfD_o = oral reference dose

Total Skin:	4.4E-02
Total Developmental:	2.0E-04
Total Cardiovascular:	2.0E-04
Total Nervous System:	2.0E-04

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TABLE 3.12

Residential Child - COPCs in Soil (0-10 ft) Exceeding Background Concentrations - Exposure Unit D

Potential Noncarcinogenic Hazard Index - Child Resident RME Scenario

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

COPC	RfD _o (mg/kg-day)	RfD _d (mg/kg-day)	RfC (mg/m ³)	Soil EPC (mg/kg)	ABS _d	ABS _g	RfDo Target Organ	RfC Target Organ	Ingestion		Dermal		Inhalation		Total HI
									CDI (mg/kg-day)	HQ	DAD (mg/kg-day)	HQ	DAC (mg/m ³)	HQ	
Arsenic	3.0E-04	3.0E-04	3.0E-05	8.59E+00	0.030	9.5E-01	skin	developmental, cardiovascular system, nervous system	1.1E-04	3.7E-01	9.2E-06	3.1E-02	6.1E-09	2.0E-04	4.0E-01
Subtotal Hazard Indices										3.7E-01		3.1E-02		2.0E-04	
														Total HI =	4.0E-01

ABS_d = dermal absorption factor

ABS_g = gastrointestinal absorption factor

CDI = chronic daily intake

DAC = daily average concentration

DAD = dermally absorbed dose

EPC = exposure point concentration

HI = Hazard Index

HQ = Hazard Quotient

mg/kg-day = milligrams per kilogram per day

mg/m³ = milligrams per cubic meter

RfC = reference concentration

RfD_d = dermal reference dose

RfD_o = oral reference dose

Total Skin:

4.0E-01

Total Developmental:

2.0E-04

Total Cardiovascular:

2.0E-04

Total Nervous System:

2.0E-04

APPENDIX U

TABLE 3.13

Residential Adult - COPCs in Soil (0-10 ft) Exceeding Background Concentrations - Exposure Unit E
 Potential Excess Lifetime Cancer Risk - Adult/Child (Age-Adjusted) Resident RME Scenario
 St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

COPC	WOE ^a	SF _o (mg/kg-day) ⁻¹	SF _d (mg/kg-day) ⁻¹	URF (μg/m ³) ⁻¹	Soil EPC (mg/kg)	ABS _d	ABS _{gi}	Ingestion		Dermal		Inhalation		Total ELCR
								CDI (mg/kg-day)	ELCR	DAD (mg/kg-day)	ELCR	DAC (mg/m ³)	ELCR	
Benzo(a)pyrene	B2	7.3E+00	7.3E+00	1.10E-03	4.85E-02	1.3E-01	1.0E+00	7.6E-08	6E-07	3.1E-08	2E-07	1.5E-11	2E-11	8E-07
ELCR Subtotals									6E-07		2E-07		2E-11	
										Estimated Total Risk =				8E-07

^aCancer WOE Classifications:

- Group A: Human carcinogen
- Group B (B1, B2): Probable human carcinogen
- Group C: Possible human carcinogen
- Group D: Not classifiable

ABS_d = dermal absorption factor

ABS_{gi} = gastrointestinal absorption factor

CDI = chronic daily intake

DAC = daily average concentration

DAD = dermally absorbed dose

ELCR = excess lifetime cancer risk

EPC = exposure point concentration

mg/kg-day = milligrams per kilogram per day

mg/m³ = milligrams per cubic meter

SF_d = dermal slope factor

SF_o = oral slope factor

μg/m³ = microgram per cubic meter

URF = Inhalation unit risk factor

WOE = weight of evidence

APPENDIX U

TABLE 3.14

Residential Adult - COPCs in Soil (0-10 ft) Exceeding Background Concentrations - Exposure Unit E

Potential Noncarcinogenic Hazard Index - Adult Resident RME Scenario

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

COPC	RfD _o (mg/kg-day)	RfD _d (mg/kg-day)	RfC (mg/m ³)	Soil EPC (mg/kg)	ABS _d	ABS _{gi}	RfDo Target Organ	RfC Target Organ	Ingestion		Dermal		Inhalation		Total HI
									CDI (mg/kg-day)	HQ	DAD (mg/kg-day)	HQ	DAC (mg/m ³)	HQ	
Benzo(a)pyrene	NA	NA	NA	4.85E-02	1.3E-01	1.0E+00			6.6E-08	NA	NA	NA	3.4E-11	NA	NA
Subtotal Hazard Indices										NA		NA		NA	
Total HI =														NA	

ABS_d = dermal absorption factor

ABS_{gi} = gastrointestinal absorption factor

CDI = chronic daily intake

DAC = daily average concentration

DAD = dermally absorbed dose

EPC = exposure point concentration

HI = Hazard Index

HQ = Hazard Quotient

mg/kg-day = milligrams per kilogram per day

mg/m³ = milligrams per cubic meter

RfC = reference concentration

RfD_d = dermal reference dose

RfD_o = oral reference dose

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TABLE 3.15

Residential Child - COPCs in Soil (0-10 ft) Exceeding Background Concentrations - Exposure Unit E
Potential Noncarcinogenic Hazard Index - Child Resident RME Scenario
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

COPC	RfD _o (mg/kg-day)	RfD _d (mg/kg-day)	RfC (mg/m ³)	Soil EPC (mg/kg)	ABS _d	ABS _g	RfDo Target Organ	RfC Target Organ	Ingestion		Dermal		Inhalation		Total HI
									CDI (mg/kg-day)	HQ	DAD (mg/kg-day)	HQ	DAC (mg/m ³)	HQ	
Benzo(a)pyrene	NA	NA	NA	4.85E-02	0.130	1.0E+00			6.2E-07	NA	NA	NA	3.4E-11	NA	NA
Subtotal Hazard Indices										NA		NA		NA	
														Total HI =	NA

ABS_d = dermal absorption factor

ABS_g = gastrointestinal absorption factor

CDI = chronic daily intake

DAC = daily average concentration

DAD = dermally absorbed dose

EPC = exposure point concentration

HI = Hazard Index

HQ = Hazard Quotient

mg/kg-day = milligrams per kilogram per day

mg/m³ = milligrams per cubic meter

RfC = reference concentration

RfD_d = dermal reference dose

RfD_o = oral reference dose

APPENDIX U

TABLE 3.16

Residential Adult - COPCs in Soil (0-10 ft) Exceeding Background Concentrations - Exposure Unit F

Potential Excess Lifetime Cancer Risk - Adult/Child (Age-Adjusted) Resident RME Scenario

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

COPC	WOE ^a	SF _o (mg/kg-day) ⁻¹	SF _d (mg/kg-day) ⁻¹	URF (µg/m ³) ⁻¹	Soil EPC (mg/kg)	ABS _d	ABS _{gi}	Ingestion		Dermal		Inhalation		Total ELCR
								CDI (mg/kg-day)	ELCR	DAD (mg/kg-day)	ELCR	DAC (mg/m ³)	ELCR	
Benzo(a)anthracene	B2	7.3E-01	7.3E-01	1.10E-04	2.01E-01	1.3E-01	1.0E+00	3.1E-07	2E-07	1.3E-07	9E-08	6.1E-11	7E-12	3E-07
Benzo(a)pyrene	B2	7.3E+00	7.3E+00	1.10E-03	1.43E-01	1.3E-01	1.0E+00	2.2E-07	2E-06	9.2E-08	7E-07	4.3E-11	5E-11	2E-06
Benzo(b)fluoranthene	B2	7.3E-01	7.3E-01	1.10E-04	2.00E-01	1.3E-01	1.0E+00	3.1E-07	2E-07	1.3E-07	9E-08	6.0E-11	7E-12	3E-07
ELCR Subtotals									2E-06		9E-07		6E-11	
												Estimated Total Risk =		3E-06

^aCancer WOE Classifications:

Group A: Human carcinogen

Group B (B1, B2): Probable human carcinogen

Group C: Possible human carcinogen

Group D: Not classifiable

ABS_d = dermal absorption factor

ABS_{gi} = gastrointestinal absorption factor

CDI = chronic daily intake

DAC = daily average concentration

DAD = dermally absorbed dose

ELCR = excess lifetime cancer risk

EPC = exposure point concentration

mg/kg-day = milligrams per kilogram per day

mg/m³ = milligrams per cubic meter

SF_d = dermal slope factor

SF_o = oral slope factor

µg/m³ = microgram per cubic meter

URF = Inhalation unit risk factor

WOE = weight of evidence

APPENDIX U

TABLE 3.17

Residential Adult - COPCs in Soil (0-10 ft) Exceeding Background Concentrations - Exposure Unit F

Potential Noncarcinogenic Hazard Index - Adult Resident RME Scenario

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

COPC	RfD _o (mg/kg-day)	RfD _d (mg/kg-day)	RfC (mg/m ³)	Soil EPC (mg/kg)	ABS _d	ABS _g	RfDo Target Organ	RfC Target Organ	Ingestion		Dermal		Inhalation		Total HI
									CDI (mg/kg-day)	HQ	DAD (mg/kg-day)	HQ	DAC (mg/m ³)	HQ	
Benzo(a)anthracene	NA	NA	NA	2.01E-01	1.3E-01	1.0E+00			2.8E-07	NA	NA	NA	1.4E-10	NA	NA
Benzo(a)pyrene	NA	NA	NA	1.43E-01	1.3E-01	1.0E+00			2.0E-07	NA	NA	NA	1.0E-10	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	2.00E-01	1.3E-01	1.0E+00			2.7E-07	NA	NA	NA	1.4E-10	NA	NA
Subtotal Hazard Indices										NA	NA	NA	NA	NA	NA
Total HI =														NA	

ABS_d = dermal absorption factor

ABS_g = gastrointestinal absorption factor

CDI = chronic daily intake

DAC = daily average concentration

DAD = dermally absorbed dose

EPC = exposure point concentration

HI = Hazard Index

HQ = Hazard Quotient

mg/kg-day = milligrams per kilogram per day

mg/m³ = milligrams per cubic meter

RfC = reference concentration

RfD_d = dermal reference dose

RfD_o = oral reference dose

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TABLE 3.18

Residential Child - COPCs in Soil (0-10 ft) Exceeding Background Concentrations - Exposure Unit F

Potential Noncarcinogenic Hazard Index - Child Resident RME Scenario

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

COPC	RfD _o (mg/kg-day)	RfD _d (mg/kg-day)	RfC (mg/m ³)	Soil EPC (mg/kg)	ABS _d	ABS _g	RfDo Target Organ	RfC Target Organ	Ingestion		Dermal		Inhalation		Total HI
									CDI (mg/kg-day)	HQ	DAD (mg/kg-day)	HQ	DAC (mg/m ³)	HQ	
Benzo(a)anthracene	NA	NA	NA	2.01E-01	0.130	1.0E+00			2.6E-06	NA	NA	NA	1.4E-10	NA	NA
Benzo(a)pyrene	NA	NA	NA	1.43E-01	0.130	1.0E+00			1.8E-06	NA	NA	NA	1.0E-10	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	2.00E-01	0.130	1.0E+00			2.6E-06	NA	NA	NA	1.4E-10	NA	NA
Subtotal Hazard Indices										NA	NA	NA	NA	NA	NA
													Total HI =		NA

ABS_d = dermal absorption factor

ABS_g = gastrointestinal absorption factor

CDI = chronic daily intake

DAC = daily average concentration

DAD = dermally absorbed dose

EPC = exposure point concentration

HI = Hazard Index

HQ = Hazard Quotient

mg/kg-day = milligrams per kilogram per day

mg/m³ = milligrams per cubic meter

RfC = reference concentration

RfD_d = dermal reference dose

RfD_o = oral reference dose

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TABLE 3.19

Residential Adult - COPCs in Soil (0-10 ft) Exceeding Background Concentrations - Exposure Unit G
 Potential Excess Lifetime Cancer Risk - Adult/Child (Age-Adjusted) Resident RME Scenario
 St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

COPC	WOE ^a	SF _o (mg/kg-day) ⁻¹	SF _d (mg/kg-day) ⁻¹	URF (μg/m ³) ⁻¹	Soil EPC (mg/kg)	ABS _d	ABS _{gi}	Ingestion		Dermal		Inhalation		Total ELCR
								CDI (mg/kg-day)	ELCR	DAD (mg/kg-day)	ELCR	DAC (mg/m ³)	ELCR	
Arsenic	A	1.5E+00	1.5E+00	4.30E-03	7.44E+00	3.0E-02	9.5E-01	1.2E-05	2E-05	1.1E-06	2E-06	2.2E-09	1E-08	2E-05
Benzo(a)anthracene	B2	7.3E-01	7.3E-01	1.10E-04	7.30E-01	1.3E-01	1.0E+00	1.1E-06	8E-07	4.7E-07	3E-07	2.2E-10	2E-11	1E-06
Benzo(a)pyrene	B2	7.3E+00	7.3E+00	1.10E-03	5.05E-01	1.3E-01	1.0E+00	7.9E-07	6E-06	3.2E-07	2E-06	1.5E-10	2E-10	8E-06
ELCR Subtotals									2E-05		4E-06		1E-08	
Estimated Total Risk =														3E-05

^aCancer WOE Classifications:

- Group A: Human carcinogen
- Group B (B1, B2): Probable human carcinogen
- Group C: Possible human carcinogen
- Group D: Not classifiable

ABS_d = dermal absorption factor

ABS_{gi} = gastrointestinal absorption factor

CDI = chronic daily intake

DAC = daily average concentration

DAD = dermally absorbed dose

ELCR = excess lifetime cancer risk

EPC = exposure point concentration

mg/kg-day = milligrams per kilogram per day

mg/m³ = milligrams per cubic meter

SF_d = dermal slope factor

SF_o = oral slope factor

μg/m³ = microgram per cubic meter

URF = Inhalation unit risk factor

WOE = weight of evidence

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TABLE 3.20

Residential Adult - COPCs in Soil (0-10 ft) Exceeding Background Concentrations - Exposure Unit G

Potential Noncarcinogenic Hazard Index - Adult Resident RME Scenario

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

COPC	RfD _o (mg/kg-day)	RfD _d (mg/kg-day)	RfC (mg/m ³)	Soil EPC (mg/kg)	ABS _d	ABS _{gi}	RfDo Target Organ	RfC Target Organ	Ingestion		Dermal		Inhalation		Total HI
									CDI (mg/kg-day)	HQ	DAD (mg/kg-day)	HQ	DAC (mg/m ³)	HQ	
Arsenic	3.0E-04	3.0E-04	3.0E-05	7.44E+00	3.0E-02	9.5E-01	skin	developmental, cardiovascular system, nervous system	1.0E-05	3.4E-02	1.2E-06	4.1E-03	5.2E-09	1.7E-04	3.8E-02
Benzo(a)anthracene	NA	NA	NA	7.30E-01	1.3E-01	1.0E+00			1.0E-06	NA	NA	NA	5.1E-10	NA	NA
Benzo(a)pyrene	NA	NA	NA	5.05E-01	1.3E-01	1.0E+00			6.9E-07	NA	NA	NA	3.6E-10	NA	NA
Subtotal Hazard Indices										3.4E-02		4.1E-03		1.7E-04	
Total HI = 3.8E-02															

ABS_d = dermal absorption factor

ABS_{gi} = gastrointestinal absorption factor

CDI = chronic daily intake

DAC = daily average concentration

DAD = dermally absorbed dose

EPC = exposure point concentration

HI = Hazard Index

HQ = Hazard Quotient

mg/kg-day = milligrams per kilogram per day

mg/m³ = milligrams per cubic meter

RfC = reference concentration

RfD_d = dermal reference dose

RfD_o = oral reference dose

Total Skin:	3.8E-02
Total Developmental:	1.7E-04
Total Cardiovascular:	1.7E-04
Total Nervous System:	1.7E-04

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TABLE 3.21

Residential Child - COPCs in Soil (0-10 ft) Exceeding Background Concentrations - Exposure Unit G
Potential Noncarcinogenic Hazard Index - Child Resident RME Scenario
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

COPC	RfD _o (mg/kg-day)	RfD _d (mg/kg-day)	RfC (mg/m ³)	Soil EPC (mg/kg)	ABS _d	ABS _g	RfDo Target Organ	RfC Target Organ	Ingestion		Dermal		Inhalation		Total HI
									CDI (mg/kg-day)	HQ	DAD (mg/kg-day)	HQ	DAC (mg/m ³)	HQ	
Arsenic	3.0E-04	3.0E-04	3.0E-05	7.44E+00	0.030	9.5E-01	skin	developmental, cardiovascular system, nervous system	9.5E-05	3.2E-01	8.0E-06	2.7E-02	5.2E-09	1.7E-04	3.4E-01
Benzo(a)anthracene	NA	NA	NA	7.30E-01	0.130	1.0E+00			9.3E-06	NA	NA	NA	5.1E-10	NA	NA
Benzo(a)pyrene	NA	NA	NA	5.05E-01	0.130	1.0E+00			6.5E-06	NA	NA	NA	3.6E-10	NA	NA
Subtotal Hazard Indices									3.2E-01		2.7E-02		1.7E-04		Total HI = 3.4E-01

ABS_d = dermal absorption factor

ABS_g = gastrointestinal absorption factor

CDI = chronic daily intake

DAC = daily average concentration

DAD = dermally absorbed dose

EPC = exposure point concentration

HI = Hazard Index

HQ = Hazard Quotient

mg/kg-day = milligrams per kilogram per day

mg/m³ = milligrams per cubic meter

RfC = reference concentration

RfD_d = dermal reference dose

RfD_o = oral reference dose

Total Skin:	3.4E-01
Total Developmental:	1.7E-04
Total Cardiovascular:	1.7E-04
Total Nervous System:	1.7E-04

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TABLE 3.22

Residential Adult - COPCs in Soil (0-10 ft) Exceeding Background Concentrations - Exposure Unit H

Potential Excess Lifetime Cancer Risk - Adult/Child (Age-Adjusted) Resident RME Scenario

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

COPC	WOE ^a	SF _o (mg/kg-day) ⁻¹	SF _d (mg/kg-day) ⁻¹	URF (μg/m ³) ⁻¹	Soil EPC (mg/kg)	ABS _d	ABS _{gi}	Ingestion		Dermal		Inhalation		Total ELCR
								CDI (mg/kg-day)	ELCR	DAD (mg/kg-day)	ELCR	DAC (mg/m ³)	ELCR	
Benzo(a)anthracene	B2	7.3E-01	7.3E-01	1.10E-04	3.25E-01	1.3E-01	1.0E+00	5.1E-07	4E-07	2.1E-07	2E-07	9.8E-11	1E-11	5E-07
Benzo(a)pyrene	B2	7.3E+00	7.3E+00	1.10E-03	2.26E-01	1.3E-01	1.0E+00	3.5E-07	3E-06	1.5E-07	1E-06	6.8E-11	8E-11	4E-06
Benzo(b)fluoranthene	B2	7.3E-01	7.3E-01	1.10E-04	4.70E-01	1.3E-01	1.0E+00	7.3E-07	5E-07	3.0E-07	2E-07	1.4E-10	2E-11	8E-07
ELCR Subtotals									3E-06		1E-06		1E-10	
Estimated Total Risk =														5E-06

^aCancer WOE Classifications:

Group A: Human carcinogen

Group B (B1, B2): Probable human carcinogen

Group C: Possible human carcinogen

Group D: Not classifiable

ABS_d = dermal absorption factor

ABS_{gi} = gastrointestinal absorption factor

CDI = chronic daily intake

DAC = daily average concentration

DAD = dermally absorbed dose

ELCR = excess lifetime cancer risk

EPC = exposure point concentration

mg/kg-day = milligrams per kilogram per day

mg/m³ = milligrams per cubic meter

SF_d = dermal slope factor

SF_o = oral slope factor

μg/m³ = microgram per cubic meter

URF = Inhalation unit risk factor

WOE = weight of evidence

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TABLE 3.23

Residential Adult - COPCs in Soil (0-10 ft) Exceeding Background Concentrations - Exposure Unit H
Potential Noncarcinogenic Hazard Index - Adult Resident RME Scenario
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

COPC	RfD _o (mg/kg-day)	RfD _d (mg/kg-day)	RfC (mg/m ³)	Soil EPC (mg/kg)	ABS _d	ABS _g	RfDo Target Organ	RfC Target Organ	Ingestion		Dermal		Inhalation		Total HI
									CDI (mg/kg-day)	HQ	DAD (mg/kg-day)	HQ	DAC (mg/m ³)	HQ	
Benzo(a)anthracene	NA	NA	NA	3.25E-01	1.3E-01	1.0E+00			4.5E-07	NA	NA	NA	2.3E-10	NA	NA
Benzo(a)pyrene	NA	NA	NA	2.26E-01	1.3E-01	1.0E+00			3.1E-07	NA	NA	NA	1.6E-10	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	4.70E-01	1.3E-01	1.0E+00			6.4E-07	NA	NA	NA	3.3E-10	NA	NA
Subtotal Hazard Indices										NA	NA	NA	NA	NA	NA
Total HI =														NA	NA

ABS_d = dermal absorption factor

ABS_g = gastrointestinal absorption factor

CDI = chronic daily intake

DAC = daily average concentration

DAD = dermally absorbed dose

EPC = exposure point concentration

HI = Hazard Index

HQ = Hazard Quotient

mg/kg-day = milligrams per kilogram per day

mg/m³ = milligrams per cubic meter

RfC = reference concentration

RfD_d = dermal reference dose

RfD_o = oral reference dose

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TABLE 3.24

Residential Child - COPCs in Soil (0-10 ft) Exceeding Background Concentrations - Exposure Unit H

Potential Noncarcinogenic Hazard Index - Child Resident RME Scenario

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

COPC	RfD _o (mg/kg-day)	RfD _d (mg/kg-day)	RfC (mg/m ³)	Soil EPC (mg/kg)	ABS _d	ABS _{gi}	RfDo Target Organ	RfC Target Organ	Ingestion		Dermal		Inhalation		Total HI
									CDI (mg/kg-day)	HQ	DAD (mg/kg-day)	HQ	DAC (mg/m ³)	HQ	
Benzo(a)anthracene	NA	NA	NA	3.25E-01	0.130	1.0E+00			4.2E-06	NA	NA	NA	2.3E-10	NA	NA
Benzo(a)pyrene	NA	NA	NA	2.26E-01	0.130	1.0E+00			2.9E-06	NA	NA	NA	1.6E-10	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	4.70E-01	0.130	1.0E+00			6.0E-06	NA	NA	NA	3.3E-10	NA	NA
Subtotal Hazard Indices										NA		NA		NA	
Total HI =														NA	

ABS_d = dermal absorption factor

ABS_{gi} = gastrointestinal absorption factor

CDI = chronic daily intake

DAC = daily average concentration

DAD = dermally absorbed dose

EPC = exposure point concentration

HI = Hazard Index

HQ = Hazard Quotient

mg/kg-day = milligrams per kilogram per day

mg/m³ = milligrams per cubic meter

RfC = reference concentration

RfD_d = dermal reference dose

RfD_o = oral reference dose

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TABLE 3.25

Residential Adult - COPCs in Soil (0-10 ft) Exceeding Background Concentrations - Exposure Unit I
Potential Excess Lifetime Cancer Risk - Adult/Child (Age-Adjusted) Resident RME Scenario
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

COPC	WOE ^a	SF _o		URF	Soil EPC (mg/kg)	ABS _d	ABS _{gi}	Ingestion		Dermal		Inhalation		Total ELCR
		(mg/kg-day) ⁻¹	(mg/kg-day) ⁻¹					CDI (mg/kg-day)	ELCR	DAD (mg/kg-day)	ELCR	DAC (mg/m ³)	ELCR	
Arsenic	A	1.5E+00	1.5E+00	4.30E-03	8.18E+00	3.0E-02	9.5E-01	1.3E-05	2E-05	1.2E-06	2E-06	2.5E-09	1E-08	2E-05
Benzo(a)pyrene	B2	7.3E+00	7.3E+00	1.10E-03	5.07E-02	1.3E-01	1.0E+00	7.9E-08	6E-07	3.3E-08	2E-07	1.5E-11	2E-11	8E-07
ELCR Subtotals									2E-05		2E-06		1E-08	
Estimated Total Risk =														2E-05

^aCancer WOE Classifications:

Group A: Human carcinogen

Group B (B1, B2): Probable human carcinogen

Group C: Possible human carcinogen

Group D: Not classifiable

ABS_d = dermal absorption factor

ABS_{gi} = gastrointestinal absorption factor

CDI = chronic daily intake

DAC = daily average concentration

DAD = dermally absorbed dose

ELCR = excess lifetime cancer risk

EPC = exposure point concentration

mg/kg-day = milligrams per kilogram per day

mg/m³ = milligrams per cubic meter

SF_d = dermal slope factor

SF_o = oral slope factor

μg/m³ = microgram per cubic meter

URF = Inhalation unit risk factor

WOE = weight of evidence

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TABLE 3.26

Residential Adult - COPCs in Soil (0-10 ft) Exceeding Background Concentrations - Exposure Unit I

Potential Noncarcinogenic Hazard Index - Adult Resident RME Scenario

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

COPC	RfD _o (mg/kg-day)	RfD _d (mg/kg-day)	RfC (mg/m ³)	Soil EPC (mg/kg)	ABS _d	ABS _g	RfDo Target Organ	RfC Target Organ	Ingestion		Dermal		Inhalation		Total HI
									CDI (mg/kg-day)	HQ	DAD (mg/kg-day)	HQ	DAC (mg/m ³)	HQ	
Arsenic	3.0E-04	3.0E-04	3.0E-05	8.18E+00	3.0E-02	9.5E-01	skin	developmental, cardiovascular system, nervous system	1.1E-05	3.7E-02	1.3E-06	4.5E-03	5.8E-09	1.9E-04	4.2E-02
Benzo(a)pyrene	NA	NA	NA	5.07E-02	1.3E-01	1.0E+00			6.9E-08	NA	NA	NA	3.6E-11	NA	NA
Subtotal Hazard Indices										3.7E-02		4.5E-03		1.9E-04	
														Total HI =	4.2E-02

ABS_d = dermal absorption factor

ABS_g = gastrointestinal absorption factor

CDI = chronic daily intake

DAC = daily average concentration

DAD = dermally absorbed dose

EPC = exposure point concentration

HI = Hazard Index

HQ = Hazard Quotient

mg/kg-day = milligrams per kilogram per day

mg/m³ = milligrams per cubic meter

RfC = reference concentration

RfD_d = dermal reference dose

RfD_o = oral reference dose

Total Skin:	4.2E-02
Total Developmental:	1.9E-04
Total Cardiovascular:	1.9E-04
Total Nervous System:	1.9E-04

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TABLE 3.27

Residential Child - COPCs in Soil (0-10 ft) Exceeding Background Concentrations - Exposure Unit I
Potential Noncarcinogenic Hazard Index - Child Resident RME Scenario
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

COPC	RfD _o (mg/kg-day)	RfD _d (mg/kg-day)	RfC (mg/m ³)	Soil EPC (mg/kg)	ABS _d	ABS _{gi}	RfDo Target Organ	RfC Target Organ	Ingestion		Dermal		Inhalation		Total HI
									CDI (mg/kg-day)	HQ	DAD (mg/kg-day)	HQ	DAC (mg/m ³)	HQ	
Arsenic	3.0E-04	3.0E-04	3.0E-05	8.18E+00	0.030	9.5E-01	skin	developmental, cardiovascular system, nervous system	1.0E-04	3.5E-01	8.8E-06	2.9E-02	5.8E-09	1.9E-04	3.8E-01
Benzo(a)pyrene	NA	NA	NA	5.07E-02	0.130	1.0E+00			6.5E-07	NA	NA	NA	3.6E-11	NA	NA
Subtotal Hazard Indices										3.5E-01		2.9E-02		1.9E-04	
														Total HI =	3.8E-01

ABS_d = dermal absorption factor

ABS_{gi} = gastrointestinal absorption factor

CDI = chronic daily intake

DAC = daily average concentration

DAD = dermally absorbed dose

EPC = exposure point concentration

HI = Hazard Index

HQ = Hazard Quotient

mg/kg-day = milligrams per kilogram per day

mg/m³ = milligrams per cubic meter

RfC = reference concentration

RfD_d = dermal reference dose

RfD_o = oral reference dose

Total Skin:	3.8E-01
Total Developmental:	1.9E-04
Total Cardiovascular:	1.9E-04
Total Nervous System:	1.9E-04

APPENDIX U

TABLE 3.28

Residential Adult - COPCs in Soil (0-10 ft) Exceeding Background Concentrations - Exposure Unit J

Potential Excess Lifetime Cancer Risk - Adult/Child (Age-Adjusted) Resident RME Scenario

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

COPC	WOE ^a	SF _o (mg/kg-day) ⁻¹	SF _d (mg/kg-day) ⁻¹	URF (μg/m ³) ⁻¹	Soil EPC (mg/kg)	ABS _d	ABS _g	Ingestion		Dermal		Inhalation		Total ELCR
								CDI (mg/kg-day)	ELCR	DAD (mg/kg-day)	ELCR	DAC (mg/m ³)	ELCR	
Benzo(a)anthracene	B2	7.3E-01	7.3E-01	1.10E-04	4.28E-01	1.3E-01	1.0E+00	6.7E-07	5E-07	2.8E-07	2E-07	1.3E-10	1E-11	7E-07
Benzo(a)pyrene	B2	7.3E+00	7.3E+00	1.10E-03	2.65E-01	1.3E-01	1.0E+00	4.1E-07	3E-06	1.7E-07	1E-06	8.0E-11	9E-11	4E-06
ELCR Subtotals									4E-06		1E-06		1E-10	
Estimated Total Risk =														5E-06

^aCancer WOE Classifications:

Group A: Human carcinogen

Group B (B1, B2): Probable human carcinogen

Group C: Possible human carcinogen

Group D: Not classifiable

ABS_d = dermal absorption factor

ABS_g = gastrointestinal absorption factor

CDI = chronic daily intake

DAC = daily average concentration

DAD = dermally absorbed dose

ELCR = excess lifetime cancer risk

EPC = exposure point concentration

mg/kg-day = milligrams per kilogram per day

mg/m³ = milligrams per cubic meter

SF_d = dermal slope factor

SF_o = oral slope factor

μg/m³ = microgram per cubic meter

URF = Inhalation unit risk factor

WOE = weight of evidence

APPENDIX U

TABLE 3.29

Residential Adult - COPCs in Soil (0-10 ft) Exceeding Background Concentrations - Exposure Unit J
Potential Noncarcinogenic Hazard Index - Adult Resident RME Scenario
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

COPC	RfD _o (mg/kg-day)	RfD _d (mg/kg-day)	RfC (mg/m ³)	Soil EPC (mg/kg)	ABS _d	ABS _{gi}	RfDo Target Organ	RfC Target Organ	Ingestion		Dermal		Inhalation		Total HI
									CDI (mg/kg-day)	HQ	DAD (mg/kg-day)	HQ	DAC (mg/m ³)	HQ	
Benzo(a)anthracene	NA	NA	NA	4.28E-01	1.3E-01	1.0E+00			5.9E-07	NA	NA	NA	3.0E-10	NA	NA
Benzo(a)pyrene	NA	NA	NA	2.65E-01	1.3E-01	1.0E+00			3.6E-07	NA	NA	NA	1.9E-10	NA	NA
Subtotal Hazard Indices										NA		NA		NA	
Total HI =														NA	

ABS_d = dermal absorption factor

ABS_{gi} = gastrointestinal absorption factor

CDI = chronic daily intake

DAC = daily average concentration

DAD = dermally absorbed dose

EPC = exposure point concentration

HI = Hazard Index

HQ = Hazard Quotient

mg/kg-day = milligrams per kilogram per day

mg/m³ = milligrams per cubic meter

RfC = reference concentration

RfD_d = dermal reference dose

RfD_o = oral reference dose

APPENDIX U

TABLE 3.30

Residential Child - COPCs in Soil (0-10 ft) Exceeding Background Concentrations - Exposure Unit J

Potential Noncarcinogenic Hazard Index - Child Resident RME Scenario

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

COPC	RfD _o (mg/kg-day)	RfD _d (mg/kg-day)	RfC (mg/m ³)	Soil EPC (mg/kg)	ABS _d	ABS _g	RfDo Target Organ	RfC Target Organ	Ingestion		Dermal		Inhalation		Total HI
									CDI (mg/kg-day)	HQ	DAD (mg/kg-day)	HQ	DAC (mg/m ³)	HQ	
Benzo(a)anthracene	NA	NA	NA	4.28E-01	0.130	1.0E+00			5.5E-06	NA	NA	NA	3.0E-10	NA	NA
Benzo(a)pyrene	NA	NA	NA	2.65E-01	0.130	1.0E+00			3.4E-06	NA	NA	NA	1.9E-10	NA	NA
Subtotal Hazard Indices															
Total HI =														NA	

ABS_d = dermal absorption factor

ABS_g = gastrointestinal absorption factor

CDI = chronic daily intake

DAC = daily average concentration

DAD = dermally absorbed dose

EPC = exposure point concentration

HI = Hazard Index

HQ = Hazard Quotient

mg/kg-day = milligrams per kilogram per day

mg/m³ = milligrams per cubic meter

RfC = reference concentration

RfD_d = dermal reference dose

RfD_o = oral reference dose

APPENDIX U

TABLE 3.31

Residential Adult - COPCs in Soil (0-10 ft) Exceeding Background Concentrations - Exposure Unit K
Potential Excess Lifetime Cancer Risk - Adult/Child (Age-Adjusted) Resident RME Scenario
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

COPC	WOE ^a	SF _o (mg/kg-day) ⁻¹	SF _d (mg/kg-day) ⁻¹	URF (μg/m ³) ⁻¹	Soil EPC (mg/kg)	ABS _d	ABS _{gi}	Ingestion		Dermal		Inhalation		Total ELCR
								CDI (mg/kg-day)	ELCR	DAD (mg/kg-day)	ELCR	DAC (mg/m ³)	ELCR	
Arsenic	A	1.5E+00	1.5E+00	4.30E-03	6.63E+00	3.0E-02	9.5E-01	1.0E-05	2E-05	9.8E-07	1E-06	2.0E-09	9E-09	2E-05
Benzo(a)anthracene	B2	7.3E-01	7.3E-01	1.10E-04	2.46E-01	1.3E-01	1.0E+00	3.8E-07	3E-07	1.6E-07	1E-07	7.4E-11	8E-12	4E-07
Benzo(a)pyrene	B2	7.3E+00	7.3E+00	1.10E-03	1.58E-01	1.3E-01	1.0E+00	2.5E-07	2E-06	1.0E-07	7E-07	4.8E-11	5E-11	3E-06
Benzo(b)fluoranthene	B2	7.3E-01	7.3E-01	1.10E-04	3.97E-01	1.3E-01	1.0E+00	6.2E-07	5E-07	2.6E-07	2E-07	1.2E-10	1E-11	6E-07
ELCR Subtotals									2E-05		3E-06		9E-09	
Estimated Total Risk =														2E-05

^aCancer WOE Classifications:

- Group A: Human carcinogen
- Group B (B1, B2): Probable human carcinogen
- Group C: Possible human carcinogen
- Group D: Not classifiable

ABS_d = dermal absorption factor

ABS_{gi} = gastrointestinal absorption factor

CDI = chronic daily intake

DAC = daily average concentration

DAD = dermally absorbed dose

ELCR = excess lifetime cancer risk

EPC = exposure point concentration

mg/kg-day = milligrams per kilogram per day

mg/m³ = milligrams per cubic meter

SF_d = dermal slope factor

SF_o = oral slope factor

μg/m³ = microgram per cubic meter

URF = Inhalation unit risk factor

WOE = weight of evidence

APPENDIX U

TABLE 3.32

Residential Adult - COPCs in Soil (0-10 ft) Exceeding Background Concentrations - Exposure Unit K

Potential Noncarcinogenic Hazard Index - Adult Resident RME Scenario

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

COPC	WOE ^a	RfD _o (mg/kg-day)	RfD _d (mg/kg-day)	RfC (mg/m ³)	Soil EPC (mg/kg)	ABS _d	ABS _{gi}	RfDo Target Organ	RfC Target Organ	Ingestion		Dermal		Inhalation		Total HI
										CDI (mg/kg-day)	HQ	DAD (mg/kg-day)	HQ	DAC (mg/m ³)	HQ	
Arsenic	A	3.0E-04	3.0E-04	3.0E-05	6.63E+00	3.0E-02	9.5E-01	skin	developmental, cardiovascular system, nervous system	9.1E-06	3.0E-02	1.1E-06	3.6E-03	4.7E-09	1.6E-04	3.4E-02
Benzo(a)anthracene	B2	NA	NA	NA	2.46E-01	1.3E-01	1.0E+00			3.4E-07	NA	NA	NA	1.7E-10	NA	NA
Benzo(a)pyrene	B2	NA	NA	NA	1.58E-01	1.3E-01	1.0E+00			2.2E-07	NA	NA	NA	1.1E-10	NA	NA
Benzo(b)fluoranthene	B2	NA	NA	NA	3.97E-01	1.3E-01	1.0E+00			5.4E-07	NA	NA	NA	2.8E-10	NA	NA
Subtotal Hazard Indices										3.0E-02		3.6E-03		1.6E-04		Total HI = 3.4E-02

ABS_d = dermal absorption factor

ABS_{gi} = gastrointestinal absorption factor

CDI = chronic daily intake

DAC = daily average concentration

DAD = dermally absorbed dose

EPC = exposure point concentration

HI = Hazard Index

HQ = Hazard Quotient

mg/kg-day = milligrams per kilogram per day

mg/m³ = milligrams per cubic meter

RfC = reference concentration

RfD_d = dermal reference dose

RfD_o = oral reference dose

Total Skin:	3.4E-02
Total Developmental:	1.6E-04
Total Cardiovascular:	1.6E-04
Total Nervous System:	1.6E-04

APPENDIX U

TABLE 3.33

Residential Child - COPCs in Soil (0-10 ft) Exceeding Background Concentrations - Exposure Unit K
Potential Noncarcinogenic Hazard Index - Child Resident RME Scenario
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

COPC	RfD _o (mg/kg-day)	RfD _d (mg/kg-day)	RfC (mg/m ³)	Soil EPC (mg/kg)	ABS _g	ABS _d	RfDo Target Organ	RfC Target Organ	Ingestion		Dermal		Inhalation		Total HI
									CDI (mg/kg-day)	HQ	DAD (mg/kg-day)	HQ	DAC (mg/m ³)	HQ	
Arsenic	3.0E-04	3.0E-04	3.0E-05	6.63E+00	0.030	9.5E-01	skin	developmental, cardiovascular system, nervous system	8.5E-05	2.8E-01	7.1E-06	2.4E-02	4.7E-09	1.6E-04	3.1E-01
Benzo(a)anthracene	NA	NA	NA	2.46E-01	0.130	1.0E+00			3.1E-06	NA	NA	NA	1.7E-10	NA	NA
Benzo(a)pyrene	NA	NA	NA	1.58E-01	0.130	1.0E+00			2.0E-06	NA	NA	NA	1.1E-10	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	3.97E-01	0.130	1.0E+00			5.1E-06	NA	NA	NA	2.8E-10	NA	NA
Subtotal Hazard Indices									2.8E-01		2.4E-02		1.6E-04		Total HI = 3.1E-01

ABS_d = dermal absorption factor
ABS_g = gastrointestinal absorption factor
CDI = chronic daily intake
DAC = daily average concentration
DAD = dermally absorbed dose
EPC = exposure point concentration
HI = Hazard Index
HQ = Hazard Quotient
mg/kg-day = milligrams per kilogram per day
mg/m³ = milligrams per cubic meter
RfC = reference concentration
RfD_d = dermal reference dose
RfD_o = oral reference dose

Total Skin: 3.1E-01
Total Developmental: 1.6E-04
Total Cardiovascular: 1.6E-04
Total Nervous System: 1.6E-04

APPENDIX U

TABLE 3.34

Residential Adult - COPCs in Soil (0-10 ft) Exceeding Background Concentrations - Exposure Unit L

Potential Excess Lifetime Cancer Risk - Adult/Child (Age-Adjusted) Resident RME Scenario

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

COPC	WOE ^a	SF _o (mg/kg-day) ⁻¹	SF _d (mg/kg-day) ⁻¹	URF (μg/m ³) ⁻¹	Soil EPC (mg/kg)	ABS _d	ABS _{gi}	Ingestion		Dermal		Inhalation		Total ELCR
								CDI (mg/kg-day)	ELCR	DAD (mg/kg-day)	ELCR	DAC (mg/m ³)	ELCR	
Arsenic	A	1.5E+00	1.5E+00	4.30E-03	1.01E+01	3.0E-02	9.5E-01	1.6E-05	2E-05	1.5E-06	2E-06	3.0E-09	1E-08	3E-05
Benzo(a)anthracene	B2	7.3E-01	7.3E-01	1.10E-04	5.05E-01	1.3E-01	1.0E+00	7.9E-07	6E-07	3.2E-07	2E-07	1.5E-10	2E-11	8E-07
Benzo(a)pyrene	B2	7.3E+00	7.3E+00	1.10E-03	4.75E-01	1.3E-01	1.0E+00	7.4E-07	5E-06	3.1E-07	2E-06	1.4E-10	2E-10	8E-06
Benzo(b)fluoranthene	B2	7.3E-01	7.3E-01	1.10E-04	6.04E-01	1.3E-01	1.0E+00	9.4E-07	7E-07	3.9E-07	3E-07	1.8E-10	2E-11	1E-06
ELCR Subtotals									3E-05		5E-06		1E-08	
Estimated Total Risk =														4E-05

^aCancer WOE Classifications:

Group A: Human carcinogen

Group B (B1, B2): Probable human carcinogen

Group C: Possible human carcinogen

Group D: Not classifiable

ABS_d = dermal absorption factor

ABS_{gi} = gastrointestinal absorption factor

CDI = chronic daily intake

DAC = daily average concentration

DAD = dermally absorbed dose

ELCR = excess lifetime cancer risk

EPC = exposure point concentration

mg/kg-day = milligrams per kilogram per day

mg/m³ = milligrams per cubic meter

SF_d = dermal slope factor

SF_o = oral slope factor

μg/m³ = microgram per cubic meter

URF = Inhalation unit risk factor

WOE = weight of evidence

APPENDIX U

TABLE 3.35

Residential Adult - COPCs in Soil (0-10 ft) Exceeding Background Concentrations - Exposure Unit L
Potential Noncarcinogenic Hazard Index - Adult Resident RME Scenario
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

COPC	RfD _o (mg/kg-day)	RfD _d (mg/kg-day)	RfC (mg/m ³)	Soil EPC (mg/kg)	ABS _d	ABS _{gi}	RfDo Target Organ	RfC Target Organ	Ingestion		Dermal		Inhalation		Total HI
									CDI (mg/kg-day)	HQ	DAD (mg/kg-day)	HQ	DAC (mg/m ³)	HQ	
Arsenic	3.0E-04	3.0E-04	3.0E-05	1.01E+01	3.0E-02	9.5E-01	skin	developmental, cardiovascular system, nervous system	1.4E-05	4.6E-02	1.6E-06	5.5E-03	7.1E-09	2.4E-04	5.2E-02
Benzo(a)anthracene	NA	NA	NA	5.05E-01	1.3E-01	1.0E+00			6.9E-07	NA	NA	NA	3.6E-10	NA	NA
Benzo(a)pyrene	NA	NA	NA	4.75E-01	1.3E-01	1.0E+00			6.5E-07	NA	NA	NA	3.3E-10	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	6.04E-01	1.3E-01	1.0E+00			8.3E-07	NA	NA	NA	4.3E-10	NA	NA
Subtotal Hazard Indices										4.6E-02		5.5E-03		2.4E-04	
														Total HI =	5.2E-02

ABS_d = dermal absorption factor

ABS_{gi} = gastrointestinal absorption factor

CDI = chronic daily intake

DAC = daily average concentration

DAD = dermally absorbed dose

EPC = exposure point concentration

HI = Hazard Index

HQ = Hazard Quotient

mg/kg-day = milligrams per kilogram per day

mg/m³ = milligrams per cubic meter

RfC = reference concentration

RfD_d = dermal reference dose

RfD_o = oral reference dose

Total Skin:	5.1E-02
Total Developmental:	2.4E-04
Total Cardiovascular:	2.4E-04
Total Nervous System:	2.4E-04

APPENDIX U

TABLE 3.36

Residential Child - COPCs in Soil (0-10 ft) Exceeding Background Concentrations - Exposure Unit L
Potential Noncarcinogenic Hazard Index - Child Resident RME Scenario
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

COPC	WOE ^a	RfD _o	RfD _d	RfC	Soil EPC	ABS _d	ABS _{gi}	RfDo Target	RfC Target Organ	Ingestion		Dermal		Inhalation		Total HI	
		(mg/kg-day)	(mg/kg-day)	(mg/m ³)	(mg/kg)			Organ		CDI (mg/kg-day)	HQ	DAD (mg/kg-day)	HQ	DAC (mg/m ³)	HQ		
Arsenic	A	3.0E-04	3.0E-04	3.0E-05	1.01E+01	0.030	9.5E-01	skin	developmental, cardiovascular system, nervous system	1.3E-04	4.3E-01	1.1E-05	3.6E-02	7.1E-09	2.4E-04	4.6E-01	
Benzo(a)anthracene	B2	NA	NA	NA	5.05E-01	0.130	1.0E+00			6.5E-06	NA	NA	NA	3.6E-10	NA	NA	
Benzo(a)pyrene	B2	NA	NA	NA	4.75E-01	0.130	1.0E+00			6.1E-06	NA	NA	NA	3.3E-10	NA	NA	
Benzo(b)fluoranthene	B2	NA	NA	NA	6.04E-01	0.130	1.0E+00			7.7E-06	NA	NA	NA	4.3E-10	NA	NA	
Subtotal Hazard Indices										4.3E-01		3.6E-02		2.4E-04		Total HI = 4.6E-01	

ABS_d = dermal absorption factor

ABS_{gi} = gastrointestinal absorption factor

CDI = chronic daily intake

DAC = daily average concentration

DAD = dermally absorbed dose

EPC = exposure point concentration

HI = Hazard Index

HQ = Hazard Quotient

mg/kg-day = milligrams per kilogram per day

mg/m³ = milligrams per cubic meter

RfC = reference concentration

RfD_d = dermal reference dose

RfD_o = oral reference dose

Total Skin:	4.6E-01
Total Developmental:	2.4E-04
Total Cardiovascular:	2.4E-04
Total Nervous System:	2.4E-04

Evaluation of Manganese Concentrations in Soil at the St. Louis Ordnance Plant, Former Hanley Area

PREPARED FOR: U.S. Army Corps of Engineers – Kansas City District
PREPARED BY: CH2M HILL
DATE: October 27, 2009

This memorandum evaluates manganese concentrations in soil at the St. Louis Ordnance Plant, former Hanley Area, to assess whether the manganese is site-related or naturally occurring.

Background

In its review of the draft final remedial investigation (RI) report, the Missouri Department of Health and Senior Services (MDHSS) expressed concern with the risk calculations pertaining to construction workers. MDHSS noted that the construction worker scenario involves a high soil contact rate and exposure to increased emissions of particulates and volatiles. Thus, MDHSS requested that the human health risk assessment (HHRA) calculate the particulate emission factor (PEF) and volatilization factor (VF) for the construction worker scenario in accordance with the U.S. Environmental Protection Agency's (USEPA's) *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (USEPA 2002).

Updated Inhalation Risk Calculations for Construction Workers

In response to MDHSS's concerns, two separate construction-worker-specific PEFs were calculated for the site based on the USEPA guidance:

- A construction worker PEF accounting for wind erosion, excavation, dozing, grading, and tilling within a construction area
- A construction worker PEF accounting for traffic on unpaved roads

Based on these two source-specific PEFs, a comprehensive PEF of 7.58×10^6 cubic meters per kilogram (m^3/kg) was calculated, as compared to the PEF ($1.36 \times 10^9 \text{ m}^3/\text{kg}$) that was presented in the draft final RI report.

Construction worker-specific VFs were also calculated for the site, although volatile organic compounds (VOCs) were chemicals of potential concern (COPCs) in only one of 12 residential exposure units (Unit L), because dissolved-phase groundwater contamination is present there.

Using the calculated PEFs and VFs, inhalation risk estimates for construction workers were calculated for each residential exposure unit (A through L). The resulting hazard indexes (HIs) exceeded the target level of 1.0 in all 12 exposure units. Manganese was the primary risk driver in every exposure unit; manganese HIs ranged from 1.0 to 1.7. Risk calculations

are presented in Tables 1 through 5, and they are described in more detail in a September 22, 2009, correspondence from the Army to MDHSS (CH2M HILL 2009b).

Need for Further Evaluation of Manganese Concentrations in Soil

After observing that manganese was the primary inhalation risk driver for construction workers, the Army concluded that manganese is naturally-occurring at the former Hanley Area and is not site-related (CH2M HILL 2009c). This position was consistent with the RI Work Plan (CH2M HILL 2008) which the Missouri Department of Natural Resources (MDNR) approved in a letter dated May 19, 2008. In correspondence dated July 22, 2009 (CH2M HILL 2009c), the Army noted its intention to discuss potential inhalation risk to construction workers in the uncertainty section of the HHRA in the final RI report.

The Army's position prompted an August 24, 2009, teleconference among the U.S. Army Corps of Engineers – Kansas City District (USACE), 88th Regional Support Command (88th RSC), CH2M HILL, MDHSS, MDNR, and USEPA. During the teleconference, the Army noted that manganese was not a primary material or by-product associated with previous industrial activities at the former Hanley Area. MDHSS and MDNR requested that, for the sake of transparency to the public, the Army provide written justification as to why it was concluded that manganese is naturally-occurring in soil across the former Hanley Area. This request was made, in part, because manganese powder may have been an ingredient in delay powder that was used at the site. It was agreed that the Army would evaluate the spatial distribution of manganese and perform a statistical analysis of manganese concentrations, if warranted.

Evaluation Approach

In accordance with the August 24, 2009, teleconference, a two-tiered evaluation approach was used to assess whether manganese concentrations are naturally-occurring or site-related. The first tier evaluated the spatial distribution of manganese. If the evaluation findings indicated the presence of manganese "hot spots" (suggesting a site release) or elevated manganese concentrations within a specific area of the site, then a second tier of evaluation, consisting of a statistical analysis, would be performed on the manganese concentrations. Possible statistical approaches discussed during the August 24, 2009, teleconference included the following:

- Construct probability plots to assess the presence of one or more inflection points that would indicate a possible separation between naturally occurring and site-related manganese concentrations
- Develop a robust upper tolerance limit (UTL) for manganese

Spatial Distribution of Manganese

To evaluate the spatial distribution of manganese, historic concentrations were compiled from environmental investigations and plotted on a site map. Figure 1 displays manganese concentrations in soil in 98 samples collected between 0 and 10 feet below ground. The sample dataset is identical to the one used to estimate risk to construction workers in the RI report.

Assessment of Manganese Hotspots

The data presented in Figure 1 were evaluated to assess whether isolated locations of elevated manganese concentrations ("hotspots") were evident. Section 6.5.3 of USEPA guidance (1989) states:

In some cases, contamination may be unevenly distributed across a site, resulting in hot spots (areas of high contamination relative to other areas of the site). If a hot spot is located near an area which, because of site or population characteristics, is visited or used more frequently, exposure to the hot spot should be assessed separately.

Based on CH2M HILL's professional experience implementing this concept on Superfund sites around the U.S., 100 times the risk-based screening level is often used to trigger the potential presence of a hotspot. However, for this project, a conservative approach was used and 10 times the minimum detected concentration was applied as a trigger to indicate the potential presence of a hotspot.

Manganese concentrations across the site range from 306 milligrams per kilogram (mg/kg) at sample location PW12 to 1,120 mg/kg at sample location SS49B. The sitewide mean concentration of manganese is 669 mg/kg. Because manganese concentrations across the site are within an order of magnitude of each other, there are no manganese hotspots at the former Hanley Area. As noted in the RI work plan and the RI report, manganese concentrations across the former Hanley Area are comparable to the geometric mean of 740 mg/kg for Missouri soils published in Tidball (1984). The range of manganese concentrations detected at the site in comparison to the published geometric mean background concentration further supports the conclusion that no manganese hot spots exist at the former Hanley Area.

Distribution of Sitewide Manganese Concentrations

To evaluate the spatial distribution of detected manganese concentrations, ranges of manganese concentrations were compared within each exposure unit. This comparison was performed to assess whether higher manganese concentrations were clustered within a particular area of the site (such as within a single exposure unit). Figure 2 presents the minimum, maximum, and mean detected manganese concentrations and the resulting HI estimates for manganese inhalation exposures by construction workers. As shown, mean concentrations within each exposure unit were similar, ranging from 511 to 814 mg/kg.

As noted, the maximum detected manganese concentration at the former Hanley Area was 1,120 mg/kg. Manganese concentrations in the upper end of the sitewide range—those exceeding 1,000 mg/kg—were observed in 7 of 12 exposure units, indicating that the highest manganese concentrations were not clustered within a single area of the site.

Statistical Evaluation of Manganese

A statistical evaluation of manganese was performed to further assess whether it is naturally occurring or a site-related contaminant. This was done by constructing probability plots of the manganese data.

Overview of Probability Plots

Probability plots provide a visual tool for identifying possible inflections or breakpoints in the dataset. They graph actual concentrations against theoretical quantiles if the true distribution of the data were normal. The quantiles are the number of standard deviations from the mean for the theoretical dataset, assuming the data are distributed normally. Transformations (e.g., log-transformations) are sometimes explored to determine whether the transformed data might be normal, even when the raw data are not. When the data or the transformed data are approximately distributed normally, the resulting plot is a straight line. When deviations from normality occur, the plot veers from a straight-line pattern.

If a dataset contains both naturally occurring and affected samples, one might expect the two distributions to appear as separate representations on the probability plot. Although it is possible for the impact to be so small in many samples that the plot maintains a smooth curve, it is also possible that the affected data will cause a clear inflection in the curve. The appearance of an inflection can serve as a marker for the onset of the affected data, and the naturally occurring concentrations would be those values with lower concentrations than the inflection point.

Sample Population used in Probability Plots

A population of 98 samples was used to construct probability plots for manganese at the former Hanley Area. The sample population is identical to the one discussed above, used to evaluate the spatial distribution of manganese. It corresponds to the soil sample population used to estimate construction worker risk in the HHRA.

Table 6 presents the individual manganese concentrations, sorted in order of decreasing concentration, used to construct probability plots. As shown in Table 6, manganese concentrations from the 1991 investigation generally were higher than those from subsequent investigations. The 8 highest manganese concentrations, and 17 of the 20 highest concentrations, were collected during the 1991 investigation. The 1991 samples comprised 22 of the 98 samples in the overall population.

To assess possible reasons for the higher concentrations observed in 1991, three explanations were considered:

- The 1991 and post-1991 samples may have been collected in different areas of the site.
- Site work (such as remedial actions) may have altered manganese concentrations in soil after 1991.
- Different analytical methods may have been used in the 1991 and post-1991 investigations.

The first two factors do not appear to apply. As shown in Figures 1 and 2, samples collected in 1991 and later spread across the site were not localized or clustered. Second, no remedial or removal actions were performed between 1991 and the subsequent investigation (2001) used to obtain the sample population. Several buildings at the former Hanley Area were demolished in 2004, so some soil disturbance may have occurred in those areas between the 2001 and 2005 investigations. However, such disturbance does not appear to have affected

soil concentrations of manganese, as the 2005 concentrations are comparable to those detected in 2001.

The third factor—different analytical methods—may account for the difference between manganese concentrations detected in 1991 and those detected later. The 1991 investigation analyzed manganese in soil samples using U.S. Army Toxic and Hazardous Materials Agency Method JS11, whereas subsequent investigations analyzed manganese using SW-846 Method 6010. Methods JS11 and 6010 use the same equipment for analysis but likely have different sample preparation procedures. These variances likely contribute to the differences observed between the 1991 and post-1991 samples.

The differences between the 1991 and post-1991 manganese concentrations are subtle. As noted, manganese concentrations across the entire site were within one order of magnitude, ranging from 306 to 1,120 mg/kg. The differences, though subtle, are important to consider, because such subtleties could emerge as apparent probability-plot inflections that do not represent a true break point between naturally occurring and site-related concentrations.

Because of the different analytical method used in 1991, two probability plots were constructed for manganese: one for the 1991 samples, and another for post-1991 samples. As discussed, each plot presents the manganese concentration along the *y* axis against the estimated quantile, assuming a normal distribution of the dataset along the *x* axis. Figure 3 shows the probability plots for the normal distribution. The plots were inspected for the presence of concentration breakpoints that would distinguish naturally occurring background concentrations from those affected by historic site activities.

Evaluation of Probability Plots

Figure 3 shows a relatively smooth curve in the 1991 probability plot and a nearly straight-line distribution for the post-1991 plot. To further evaluate the data, probability plots were constructed assuming lognormal instead of a normal distribution. The plots, presented in Figure 4, display a nearly straight-line pattern for both datasets, further suggesting that breakpoints do not exist.

Because no obvious breakpoints exist in the probability plots for manganese, the measured concentrations appear to represent naturally occurring concentrations in soil, rather than concentrations affected by historic site releases.

Conclusions

Based on a review of manganese concentrations detected across the former Hanley Area, manganese is naturally occurring and not site-related. This is evidenced by the absence of manganese hotspots, the even distribution of manganese concentrations detected across the site, the detected concentrations being comparable to published values for Missouri soils, and the absence of inflection points in manganese probability plots. Because the detected manganese concentrations at the site are not related to former site operations or a Comprehensive Environmental Response, Compensation, and Liability Act release, manganese is not a chemical of concern.

References

CH2M HILL. 2008. *Work Plan, Remedial Investigation Report, St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri*. May.

CH2M HILL. 2009a. *Remedial Investigation, St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri*. Draft Final. March.

CH2M HILL 2009b. Responses to Missouri Department of Health and Senior Services Correspondence on the Draft Final Remedial Investigation Report for the St. Louis Ordnance Plant, Former Hanley Area. September 22.

CH2M HILL 2009c. Responses to Missouri Department of Health and Senior Services Correspondence on the Draft Final Remedial Investigation Report for the St. Louis Ordnance Plant, Former Hanley Area. July 22.

Tidball, R. R. 1984. *Geochemical Survey of Missouri*. Geological Survey Professional Paper, 954-H,1.

USEPA. 1989. *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A)*. Office of Emergency and Remedial Response. EPA/540/1-89/002.

USEPA. 2002. *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites*. OSWER 9355.4-24.

TABLE 1

Derivation of Particular Emission Factor for Particulate Emissions from Construction Activities

Construction Scenario: Construction Worker

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

PEF Equations:

$$\frac{Q}{C_{sa}} = A \times \exp \left[\frac{(\ln A_c - B)^2}{C} \right]$$

Equation E-15 (EPA, 2002)

$$PEF'_{sc} = \frac{Q}{C_{sa}} \times \frac{1}{F_D} \times \frac{1}{<J'_T>}$$

Equation E-26 (EPA, 2002)

$$<J'_T> = \frac{M_{wind} + M_{excav} + M_{doz} + M_{grade} + M_{till}}{A_c \times T}$$

Equation E-25 (EPA, 2002)

$$F_D = 0.1852 + \frac{5.3537}{t_c} + \frac{-9.6318}{t_c^2}$$

Equation E-16 (EPA, 2002)

PEF and Box Model Input Parameters

Parameter	Definition	Value	Units	Source
Q/C_{sa}	inverse ratio of the geometric mean air concentration to the emission flux at the center of a square source	12.80	m	Eqn. E-15
A	Constant	2.4538	unitless	default (Eqn. E-15)
B	Constant	17.5660	unitless	default (Eqn. E-15)
C	Constant	189.0426	unitless	default (Eqn. E-15)
A_c	Areal extent of site contamination	0.9	acres	assumed
PEF_{sc}	subchronic road particulate emission factor	7.55E+07	m ³ /kg	Eqn. E-26
F_D	Dispersion correction factor	0.186	unitless	Eqn. E-16
t_c	duration of construction (1 year = 365 days x 24 hr/day)	8,760	hr	assumed
$<J'_T>$	Total time-averaged PM10 unit emission flux for construction activities other than traffic on unpaved roads	9.1.E-07	g/m ² -s	Eqn. E-25
Mwind	Unit mass emitted from wind erosion	1.6.E+04	g	Eqn. E-20 ^a
Mexcav	Unit mass emitted from excavation soil	1.5.E+03	g	Eqn. E-21 ^a
Mdoz	Unit mass emitted from dozing operations	1.3.E+02	g	Eqn. E-22 ^a
Mgrade	Unit mass emitted from grading operations	1.9.E+03	g	Eqn. E-23 ^a
Mtill	Unit mass emitted from tilling operations	4.5.E+03	g	Eqn. E-24 ^a
Asurf	Areal extent of site with surface soil contamination	0.9	acre	Eqn. E-20
Aexcav	Areal extent of excavation	0.9	acre	Eqn. E-21
dexcav	Average depth of excavation	1.0	m	Eqn. E-21
ΣVKT	Sum of dozing kilometers traveled	4.43	km	Eqn. E-22 ^b
ΣVKT	Sum of grading kilometers traveled	4.43	km	Eqn. E-23 ^b
Atill	Areal extent of tilling	0.9	acre	Eqn. E-24
T	Total time over which construction occurs (1 yr x 250 days/yr x 8 hrs/day x 3600 s/hr)	7.2.E+06	s	assumed

Source:

EPA, 2002. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, EPA

Office of Solid Waste and Emergency Response. OSWER 9355.4-24. December.

^aDefault input parameters used to calculate emitted unit mass can be found in Appendix E of the EPA guidance document (2002).^bAssuming that the dozing and grading blades each have a length of 8 ft (2.44 m) and that one dozing or grading pass across the length of the site is equal to the square root of the site area (60 m) $\Sigma VKT = (60 \text{ m}/2.44 \text{ m}) \times 60 \text{ m} \times 3) / 1000 \text{ m/km} = 4.43 \text{ km}$.

TABLE 2

Derivation of Particular Emission Factor for Particulate Emissions from Unpaved Roads

Construction Scenario: Construction Worker

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

PEF Equations:

$$\frac{Q}{C_{Sr}} = A \times \exp \left[\frac{(\ln A_{site} - B)^2}{C} \right] \quad \text{Equation 5-6 (EPA, 2002)}$$

$$PEF_{sc} = \frac{Q}{C_{Sr}} \times \frac{1}{F_D} \frac{T \times A_R}{556 \times (W/3)^{0.4} \times \left(\frac{365 \text{ d/yr} - p}{365 \text{ d/yr}} \right) \times \sum VKT} \quad \text{Equation 5-5 (EPA, 2002)}$$

$$F_D = 0.1852 + \frac{5.3537}{t_c} + \frac{-9.6318}{t_c^2} \quad \text{Equation E-16 (EPA, 2002)}$$

PEF and Box Model Input Parameters

Parameter	Definition	Value	Units	Source
Q/C_{Sr}	inverse ratio of the geometric mean air concentration to the emission flux at the center of a square source	20.8	m	Eqn. 5-6
A	Constant	12.9351	unitless	default (Eqn. 5-6)
B	Constant	5.7383	unitless	default (Eqn. 5-6)
C	Constant	71.7711	unitless	default (Eqn. 5-6)
A_{site}	Areal extent of site contamination	0.9	acres	site-specific
PEF_{sc}	subchronic road particulate emission factor	8.42E+06	m ³ /kg	Eqn. 5-5
F_D	Dispersion correction factor	0.186	unitless	Eqn. E-16
t_c	duration of construction (1 year = 365 days x 24 hr/day)	8,760	hr	assumed
T	Total time over which construction occurs (1 yr x 250 days/yr x 8 hrs/day x 3600 s/hr)	7.2.E+06	s	assumed
A_R	surface area of contaminated road segment (square root of site surface contamination configured as a square x default width of road segment of 20 ft)	367.90	m ²	calculated
W	mean weight of vehicle [(1 car @ 2 tons/car) + (2 trucks @ 20 tons/truck)] / 3 vehicles	14	tons	assumed
p	number of days with at least 0.01 inches of precipitation (based on 10/2007 data)	89	days/yr	regional data
VKT	sum of fleet vehicle kilometers traveled during the exposure duration (assumed 3 vehicles x 0.060 km/day x 250 days)	45.3	km	assumed ^a

Source:

EPA, 2002. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, EPA Office of Solid Waste and Emergency Response. OSWER 9355.4-24. December.

^aBased on the small size (0.9 acre) of the exposure area, three vehicles were conservatively assumed to generate particulates in the vicinity of a hypothetical construction worker.

TABLE 3

Derivation of Subchronic Volatilization Factor—Construction Scenario: Construction Worker
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Chemical	Diffusivity in Air (D _a) (cm ² /s)	Henry's Law Constant (H') (unitless)	Diffusivity in Water (D _w) (cm ² /s)	Soil Organic Carbon Partition Coeff. (K _{oc}) (cm ³ /g)	Soil Water Partition Coeff. (K _d = K _{oc} × F _{oc}) (g/cm ³)	Solubility in Water (S) (mg/L)	Apparent Diffusivity (D _A) (cm ² /s)	Volatilization Factor (VF) (m ³ /kg)
cis-1,2-Dichloroethene	8.80E-02	1.70E-01	1.10E-05	4.38E+01	2.63E-01	3.50E+03	2.02E-03	2.44E+02
Tetrachloroethene	5.00E-02	7.20E-01	9.50E-06	1.07E+02	6.41E-01	2.06E+02	2.19E-03	2.35E+02
Trichloroethene	6.90E-02	4.00E-01	1.00E-05	6.77E+01	4.06E-01	1.28E+03	2.53E-03	2.18E+02

$$\frac{Q}{C_{sa}} = A \times \exp \left[\frac{(\ln A_c - B)^2}{C} \right] \quad \text{Equation 5-15 (EPA, 2002)}$$

$$VF_{sc} = \left[\frac{(3.14 \times D_A \times T)^{1/2}}{2 \times \rho_b \times D_A} \right] \times 10^{-4} (m^2/cm^2) \times \frac{Q}{C_{sa}} \times \frac{1}{F_D} \quad \text{Equation 5-14 (EPA, 2002)}$$

$$D_A = \frac{\left(\theta_a^{10/3} \times D_i \times H' + \theta_w^{10/3} \times D_w \right)}{\rho_b \times K_d + \theta_w + \theta_a \times H'} \quad \text{Equation 5-14 (EPA, 2002)}$$

Parameter	Definition	Value	Units	Source
Q/C _{sa}	Inverse ratio of the geometric mean air concentration to the emission flux at the center of a square source	12.80	m	calculated
A	Constant	2.4538	unitless	default (Eqn. E-15)
B	Constant	17.5660	unitless	default (Eqn. E-15)
C	Constant	189.0426	unitless	default (Eqn. E-15)
A _c	Areal extent of site contamination	0.9	acres	assumed
T	Total time over which construction occurs (250 days × 8 hrs/day × 3600 s/hr)	7.2E+06	s	assumed
ρ _b	Soil bulk density	1.5	g/cm ³	default (Eqn. 5-14)
θ _a	Air-filled soil porosity (L _{air} /L _{water})	0.28	(L _{air} /L _{water}) = n - Q _w	calculated
n	Total soil porosity (L _{pore} /L _{soil})	0.43	(L _{pore} /L _{soil}) = 1 - (r _v /r _s)	calculated
θ _w	Water-filled soil porosity	0.15	L _{water} /L _{soil}	default (Eqn. 5-14)
ρ _s	Soil particle density	2.65	g/cm ³	default (Eqn. 5-14)
f _{oc}	Fraction organic carbon in soil	0.006	g/g	default (Eqn. 5-14)
F _D	Dispersion correction factor	0.185	unitless	default (Eqn. 5-14)

Note: Physical and chemical properties are obtained from EPA, 2009.

Sources:

EPA, 2002. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. EPA Office of Solid Waste and Emergency Response. OSWER 9355 4-24. December.

EPA, 2009. Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites. RSL Table Update. April 2009.

TABLE 4

Comparison of Potential Carcinogenic/Noncarcinogenic Risk from Soil (0–10 feet): Construction Worker RME Scenario
 St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

COPC	Soil EPC (mg/kg)	Original Risk Estimates (based on PEF of 1.36E+09 in HHRA)					New Risk Estimates (based on construction worker PEFs of 1.57E+07)				
		Carcinogenic			Noncarcinogenic		Carcinogenic			Noncarcinogenic	
		Air EPC (mg/m ³)	DAC (mg/m ³)	ELCR	DAC (mg/m ³)	HQ	Air EPC (mg/m ³)	DAC (mg/m ³)	ELCR	DAC (mg/m ³)	HQ
Arsenic	9.7E+00	7.1E-09	7.0E-11	3.0E-10	4.9E-09	1.6E-04	1.3E-06	1.3E-08	5.4E-08	8.8E-07	2.9E-02
Benzo(a)pyrene	1.9E-01	1.4E-10	1.4E-12	1.5E-12	9.5E-11	NA	2.5E-08	2.4E-10	2.7E-10	1.7E-08	NA
Tetrachloroethene	2.6E+00	1.5E-03	1.4E-05	8.4E-08	1.0E-03	3.7E-03	1.1E-02	1.1E-04	6.4E-07	7.6E-03	2.8E-02
Trichloroethene	3.8E-01	1.7E-04	1.6E-06	3.2E-09	1.1E-04	1.9E-04	1.7E-03	1.7E-05	3.4E-08	1.2E-03	2.0E-03
Total =		Total =	Total =	8.7E-08	Total =	4.0E-03	Total =	Total =	7.3E-07	Total =	5.9E-02

DAC = daily average concentration
 ELCR = excess lifetime cancer risk
 EPC = exposure point concentration
 HQ = Hazard Quotient

TABLE 5

Summary of Estimated Risks Associated with Inhalation Exposure Under Construction Worker Scenario - Exposure Units A through L: Onsite Subsurface Soil (0-10 feet)

Based on VF and PEF for Construction Activities

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Exposure Unit	COPC	Toxicity Values				Ambient Air EPC			Noncarcinogenic		Carcinogenic	
		Soil EPC (mg/kg)	RIC (mg/m ³)	URF (ug/m ³) ⁻¹	VF (kg/m ³)	Volatile (mg/m ³)	Particulate (mg/m ³)	Ambient Air EPC (Combined) (mg/m ³)	DAC (mg/m ³)	HQ	DAC (mg/m ³)	ELCR
A	Aluminum	7.1E+03	5.0E-03	NA	NA	NA	9.43E-04	9.43E-04	6.5E-04	1.3E-01	9.2E-06	NA
	Antimony	2.8E+00	NA	NA	NA	NA	3.73E-07	3.73E-07	2.6E-07	NA	3.6E-09	NA
	Iron	1.6E+04	NA	NA	NA	NA	2.12E-03	2.12E-03	1.4E-03	NA	2.1E-05	NA
	Manganese	5.6E+02	5.0E-05	NA	NA	NA	7.36E-05	7.36E-05	5.0E-05	1.0E+00	7.2E-07	NA
	Selenium	1.2E+01	NA	NA	NA	NA	1.64E-06	1.64E-06	1.1E-06	NA	1.6E-08	NA
									Total =	1.1E+00	Total =	0.0E+00
B	Aluminum	8.6E+03	5.0E-03	NA	NA	NA	1.14E-03	1.14E-03	7.8E-04	1.6E-01	1.1E-05	NA
	Antimony	3.2E+00	NA	NA	NA	NA	4.16E-07	4.16E-07	2.8E-07	NA	4.1E-09	NA
	Arsenic	1.6E+01	3.0E-05	4.3E-03	NA	NA	2.11E-06	2.11E-06	1.4E-06	4.8E-02	2.1E-08	8.9E-08
	Iron	1.4E+04	NA	NA	NA	NA	1.89E-03	1.89E-03	1.3E-03	NA	1.9E-05	NA
	Manganese	5.9E+02	5.0E-05	NA	NA	NA	7.74E-05	7.74E-05	5.3E-05	1.1E+00	7.6E-07	NA
									Total =	1.3E+00	Total =	8.9E-08
C	Aluminum	8.3E+03	5.0E-03	NA	NA	NA	1.09E-03	1.09E-03	7.5E-04	1.5E-01	1.1E-05	NA
	Antimony	4.2E+00	NA	NA	NA	NA	5.60E-07	5.60E-07	3.8E-07	NA	5.5E-09	NA
	Iron	1.8E+04	NA	NA	NA	NA	2.33E-03	2.33E-03	1.6E-03	NA	2.3E-05	NA
	Manganese	6.1E+02	5.0E-05	NA	NA	NA	8.07E-05	8.07E-05	5.5E-05	1.1E+00	7.9E-07	NA
									Total =	1.3E+00	Total =	0.0E+00
D	Aluminum	1.2E+04	5.0E-03	NA	NA	NA	1.58E-03	1.58E-03	1.1E-03	2.2E-01	1.5E-05	NA
	Iron	1.8E+04	NA	NA	NA	NA	2.40E-03	2.40E-03	1.6E-03	NA	2.3E-05	NA
	Manganese	8.4E+02	5.0E-05	NA	NA	NA	1.11E-04	1.11E-04	7.6E-05	1.5E+00	1.1E-06	NA
	Thallium	4.7E+00	NA	NA	NA	NA	6.15E-07	6.15E-07	4.2E-07	NA	6.0E-09	NA
									Total =	1.7E+00	Total =	0.0E+00
E	Aluminum	9.0E+03	5.0E-03	NA	NA	NA	1.19E-03	1.19E-03	8.2E-04	1.6E-01	1.2E-05	NA
	Antimony	1.4E+01	NA	NA	NA	NA	1.86E-06	1.86E-06	1.3E-06	NA	1.8E-08	NA
	Arsenic	1.4E+01	3.0E-05	4.3E-03	NA	NA	1.81E-06	1.81E-06	1.2E-06	4.1E-02	1.8E-08	7.6E-08
	Chromium	4.1E+01	NA	NA	NA	NA	5.47E-06	5.47E-06	3.7E-06	NA	5.4E-08	NA
	Iron	1.7E+04	NA	NA	NA	NA	2.19E-03	2.19E-03	1.5E-03	NA	2.1E-05	NA
	Manganese	8.4E+02	5.0E-05	NA	NA	NA	1.11E-04	1.11E-04	7.6E-05	1.5E+00	1.1E-06	NA
	Thallium	5.1E+00	NA	NA	NA	NA	6.69E-07	6.69E-07	4.6E-07	NA	6.5E-09	NA
	Vanadium	3.5E+01	NA	NA	NA	NA	4.65E-06	4.65E-06	3.2E-06	NA	4.6E-08	NA
									Total =	1.7E+00	Total =	7.6E-08

TABLE 5

Summary of Estimated Risks Associated with Inhalation Exposure Under Construction Worker Scenario - Exposure Units A through L: Onsite Subsurface Soil (0-10 feet)

Based on VF and PEF for Construction Activities

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

		Toxicity Values				Ambient Air EPC			Noncarcinogenic		Carcinogenic	
Exposure Unit	COPC	Soil EPC (mg/kg)	RfC (mg/m ³)	URF (ug/m ³) ⁻¹	VF (kg/m ³)	Volatile (mg/m ³)	Particulate (mg/m ³)	Ambient Air EPC (Combined) (mg/m ³)	DAC (mg/m ³)	HQ	DAC (mg/m ³)	ELCR
F	Aluminum	9.3E+03	5.0E-03	NA	NA	NA	1.23E-03	1.23E-03	8.4E-04	1.7E-01	1.2E-05	NA
	Antimony	5.7E+00	NA	NA	NA	NA	7.56E-07	7.56E-07	5.2E-07	NA	7.4E-09	NA
	Arsenic	8.5E+00	3.0E-05	4.3E-03	NA	NA	1.12E-06	1.12E-06	7.7E-07	2.6E-02	1.1E-08	4.7E-08
	Iron	1.7E+04	NA	NA	NA	NA	2.18E-03	2.18E-03	1.5E-03	NA	2.1E-05	NA
	Manganese	7.8E+02	5.0E-05	NA	NA	NA	1.02E-04	1.02E-04	7.0E-05	1.4E+00	1.0E-06	NA
	Thallium	2.2E+00	NA	NA	NA	NA	2.88E-07	2.88E-07	2.0E-07	NA	2.8E-09	NA
	Vanadium	3.2E+01	NA	NA	NA	NA	4.23E-06	4.23E-06	2.9E-06	NA	4.1E-08	NA
									Total =	1.6E+00	Total =	4.7E-08
G	Aluminum	1.1E+04	5.0E-03	NA	NA	NA	1.44E-03	1.44E-03	9.9E-04	2.0E-01	1.4E-05	NA
	Benzo(b)fluoran	8.2E-01	NA	1.1E-04	NA	NA	1.08E-07	1.08E-07	7.4E-08	NA	1.1E-09	1.2E-10
	Iron	1.8E+04	NA	NA	NA	NA	2.44E-03	2.44E-03	1.7E-03	NA	2.4E-05	NA
	Manganese	9.0E+02	5.0E-05	NA	NA	NA	1.19E-04	1.19E-04	8.2E-05	1.6E+00	1.2E-06	NA
	Thallium	5.2E+00	NA	NA	NA	NA	6.85E-07	6.85E-07	4.7E-07	NA	6.7E-09	NA
	Vanadium	3.7E+01	NA	NA	NA	NA	4.91E-06	4.91E-06	3.4E-06	NA	4.8E-08	NA
									Total =	1.8E+00	Total =	1.2E-10
H	Aluminum	8.0E+03	5.0E-03	NA	NA	NA	1.06E-03	1.06E-03	7.2E-04	1.4E-01	1.0E-05	NA
	Arsenic	1.1E+01	3.0E-05	4.3E-03	NA	NA	1.42E-06	1.42E-06	9.7E-07	3.2E-02	1.4E-08	6.0E-08
	Iron	1.5E+04	NA	NA	NA	NA	2.00E-03	2.00E-03	1.4E-03	NA	2.0E-05	NA
	Manganese	6.2E+02	5.0E-05	NA	NA	NA	8.18E-05	8.18E-05	5.6E-05	1.1E+00	8.0E-07	NA
	Silver	6.8E+01	NA	NA	NA	NA	8.98E-06	8.98E-06	6.2E-06	NA	8.8E-08	NA
	Thallium	4.5E+00	NA	NA	NA	NA	5.97E-07	5.97E-07	4.1E-07	NA	5.8E-09	NA
									Total =	1.3E+00	Total =	6.0E-08
I	Aluminum	8.8E+03	5.0E-03	NA	NA	NA	1.16E-03	1.16E-03	8.0E-04	1.6E-01	1.1E-05	NA
	Iron	1.7E+04	NA	NA	NA	NA	2.18E-03	2.18E-03	1.5E-03	NA	2.1E-05	NA
	Manganese	9.2E+02	5.0E-05	NA	NA	NA	1.22E-04	1.22E-04	8.3E-05	1.7E+00	1.2E-06	NA
	Thallium	5.8E+00	NA	NA	NA	NA	7.63E-07	7.63E-07	5.2E-07	NA	7.5E-09	NA
									Total =	1.8E+00	Total =	0.0E+00
J	Aluminum	8.4E+03	5.0E-03	NA	NA	NA	1.11E-03	1.11E-03	7.6E-04	1.5E-01	1.1E-05	NA
	Arsenic	1.3E+01	3.0E-05	4.3E-03	NA	NA	1.70E-06	1.70E-06	1.2E-06	3.9E-02	1.7E-08	7.2E-08
	Benzo(b)fluoran	4.7E-01	NA	1.1E-04	NA	NA	6.14E-08	6.14E-08	4.2E-08	NA	6.0E-10	6.6E-11
	Copper	2.1E+02	NA	NA	NA	NA	2.81E-05	2.81E-05	1.9E-05	NA	2.8E-07	NA
	Iron	1.7E+04	NA	NA	NA	NA	2.28E-03	2.28E-03	1.6E-03	NA	2.2E-05	NA
	Manganese	7.6E+02	5.0E-05	NA	NA	NA	9.99E-05	9.99E-05	6.8E-05	1.4E+00	9.8E-07	NA
	Thallium	8.6E+00	NA	NA	NA	NA	1.14E-06	1.14E-06	7.8E-07	NA	1.1E-08	NA
									Total =	1.6E+00	Total =	7.2E-08

TABLE 5

Summary of Estimated Risks Associated with Inhalation Exposure Under Construction Worker Scenario - Exposure Units A through L. Onsite Subsurface Soil (0-10 feet)

Based on VF and PEF for Construction Activities

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Exposure Unit	COPC	Soil EPC (mg/kg)	Toxicity Values			Ambient Air EPC			Noncarcinogenic		Carcinogenic	
			RfC (mg/m ³)	URF (μg/m ³) ⁻¹	VF (kg/m ³)	Volatile (mg/m ³)	Particulate (mg/m ³)	Ambient Air EPC (Combined) (mg/m ³)	DAC (mg/m ³)	HQ	DAC (mg/m ³)	ELCR
K	Aluminum	9.4E+03	5.0E-03	NA	NA	NA	1.24E-03	1.24E-03	8.5E-04	1.7E-01	1.2E-05	NA
	Iron	1.6E+04	NA	NA	NA	NA	2.18E-03	2.18E-03	1.5E-03	NA	2.1E-05	NA
	Manganese	8.4E+02	5.0E-05	NA	NA	NA	1.11E-04	1.11E-04	7.6E-05	1.5E+00	1.1E-06	NA
	Thallium	7.7E+00	NA	NA	NA	NA	1.01E-06	1.01E-06	6.9E-07	NA	9.9E-09	NA
	Vanadium	3.3E+01	NA	NA	NA	NA	4.35E-06	4.35E-06	3.0E-06	NA	4.3E-08	NA
									Total =	1.7E+00	Total =	0.0E+00
L	Aluminum	8.6E+03	5.0E-03	NA	NA	NA	1.13E-03	1.13E-03	7.8E-04	1.6E-01	1.1E-05	NA
	cis-1,2-Dichloro	2.9E-01	NA	NA	2.44E+02	1.18E-03	3.80E-08	1.18E-03	8.1E-04	NA	1.2E-05	NA
	Iron	1.8E+04	NA	NA	NA	NA	2.36E-03	2.36E-03	1.6E-03	NA	2.3E-05	NA
	Manganese	8.6E+02	5.0E-05	NA	NA	NA	1.13E-04	1.13E-04	7.8E-05	1.6E+00	1.1E-06	NA
	Selenium	6.4E+00	NA	NA	NA	NA	8.47E-07	8.47E-07	5.8E-07	NA	8.3E-09	NA
	Tetrachloroethe	2.6E+00	2.7E-01	5.9E-06	2.35E+02	1.11E-02	3.43E-07	1.11E-02	7.6E-03	2.8E-02	1.1E-04	6.4E-07
	Thallium	2.4E+00	NA	NA	NA	NA	3.12E-07	3.12E-07	2.1E-07	NA	3.0E-09	NA
	Trichloroethene	3.8E-01	6.0E-01	2.0E-06	2.18E+02	1.74E-03	5.01E-08	1.74E-03	1.2E-03	2.0E-03	1.7E-05	3.4E-08
									Total =	1.7E+00	Total =	6.7E-07

COPC - chemical of potential concern

DAC - daily average concentration

EPC - exposure point concentration

HQ - hazard quotient

RfC - reference concentration

URF - unit risk factor

VF - volatilization factor

TABLE 6

Manganese Concentrations in Soil Samples

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Sample Name	Sample Date	Exposure Unit	Start Depth (feet)	Finish Depth (feet)	Manganese Concentration (mg/kg)
SS49B	1991	I	1	2	1,120
SS46A	1991	G	0	1	1,070
SS44A	1991	E	0	1	1,060
SS50A	1991	K	0	1	1,050
SS52A	1991	L	0	1	1,050
SS43A	1991	D	0	1	1,040
SS49A	1991	I	0	1	1,040
SS47B	1991	G	1	2	1,030
SB-021	2005	F	NA	NA	1,025.3
SS47A	1991	G	0	1	991
SS50B	1991	K	1	2	978
SS51A	1991	K	0	1	964
CSS-010	2005	J	0	1	938.2
SS51B	1991	K	1	2	927
SS46B	1991	G	1	2	921
SS52B	1991	L	1	2	905
SS44B	1991	E	1	2	898
SS48A	1991	F	0	1	863
SB-013	2005	I	NA	NA	828.81
SS45B	1991	F	1	2	795
SS-218A-1	2001	J	0	1	787
SB-010	2005	G	NA	NA	780.76
SB-009	2005	G	NA	NA	766.83
SS-219D-2	2001	I	0	1	763
CSS-012	2005	J	0	1	761.9
SS43B	1991	D	1	2	753
SS-218A-3	2001	K	0	1	750
SS-218C-3	2001	G	0	1	708
SS-219G-3	2001	G	0	1	708
SS42A	1991	B	0	1	708
PW13	2001	G	7	8	695
SS-219G-2	2001	G	0	1	683
SS-219D-1	2001	I	0	1	682
SS-220-1	2001	L	0	1	676
CSS-006	2005	F	0	1	673.69
SB-019	2005	K	NA	NA	672.69
SB-012	2005	I	NA	NA	672.3
SS-219A-2	2001	K	0	1	667
SS-220-4	2001	L	0	1	665
CSS-008	2005	H	0	1	656.17
CSS-004	2005	D	0	1	654.6
SB-015	2005	K	NA	NA	652.51
SS-218B-2	2001	I	0	1	649
SB-008	2005	F	NA	NA	647.61
SS-219J-1	2001	F	0	1	639
SS45A	1991	F	0	1	638
SS-DPILE-1	2001	E	NA	NA	624
CSS-015	2005	H	0	1	622.8
SS-220-3	2001	L	0	1	622
SS-227M-1	2001	E	0	1	619
CSS-005	2005	F	0	1	617.94
SS-218C-2	2001	F	0	1	617
SS-219E	2001	H	0	1	617
SS-227A-1	2001	C	0	1	611

TABLE 6

Manganese Concentrations in Soil Samples

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Sample Name	Sample Date	Exposure Unit	Start Depth (feet)	Finish Depth (feet)	Manganese Concentration (mg/kg)
SS-219A-1	2001	K	0	1	610
SS-228E-1	2001	B	0	1	602
SS-219G-1	2001	G	0	1	601
SS41A	1991	A	0	1	601
SS48B	1991	F	1	2	597
SB-017	2005	J	NA	NA	596.45
CSS-002	2005	A	0	1	594.2
SB-014	2005	J	NA	NA	592.33
SS-220-2	2001	L	0	1	591
SB-016	2005	K	NA	NA	588.63
SS-219A-3	2001	K	0	1	581
SB-011	2005	H	NA	NA	570.17
SB-006	2005	E	0	1	564.57
CSS-013	2005	J	0	1	562
SS-219D-3	2001	I	0	1	562
SS-227J-1	2001	D	0	1	558
SS-228A-1	2001	B	0	1	551
SB-022	2005	H	NA	NA	549.8
CSS-007	2005	H	0	1	546.43
SS-236-1	2001	E	0	1	546
SB-003	2005	A	0	1	540.79
SB-018	2005	K	NA	NA	539.37
SS-218B-1	2001	H	0	1	530
SS-228WX-1	2001	A	0	1	529
CSS-014	2005	L	0	1	528.3
CSS-003	2005	C	0	1	526.6
SS-228YZ-1	2001	A	0	1	518
CSS-001	2005	A	0	1	516.8
SS-219H	2001	F	0	1	516
SS-228M-1	2001	A	0	1	512
SS-227O-1	2001	E	0	1	509
SS-228B-1	2001	B	0	1	502
SB-001	2005	A	NA	NA	486.62
SS-227B-1	2001	C	0	1	483
SS-228C-1	2001	B	0	1	472
SS-228F-1	2001	B	0	1	463
SS-228D-1	2001	B	0	1	461
SS-218C-1	2001	D	0	1	460
SS-228G-1	2001	A	0	1	440
SB-002	2005	B	NA	NA	435.2
SB-005	2005	C	NA	NA	423.08
CSS-011	2005	J	0	1	406.9
CSS-009	2005	J	0	1	336.26
PW12	2001	D	7	8	306

Notes:

mg/kg = milligrams per kilogram

NA = information not available

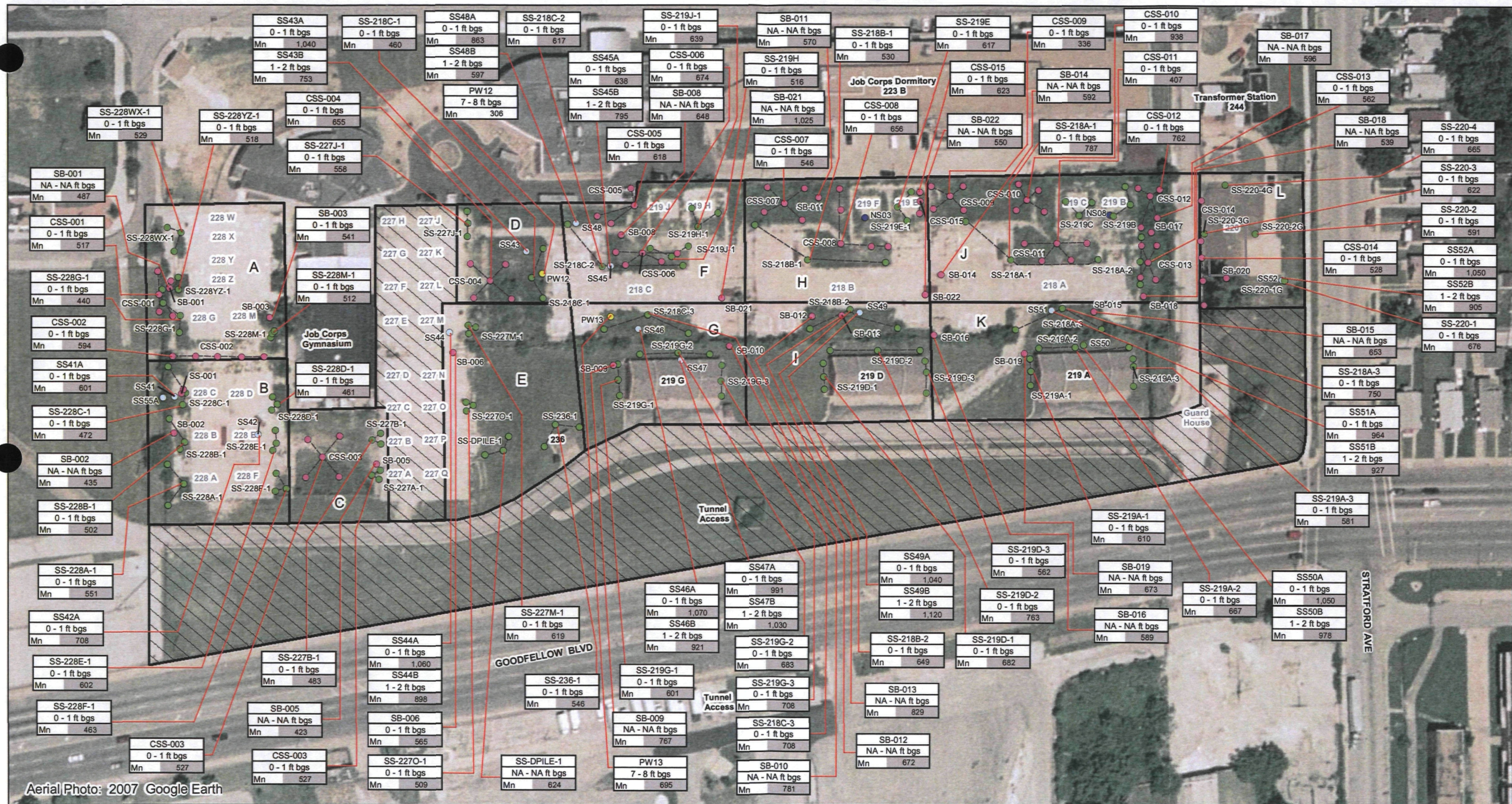
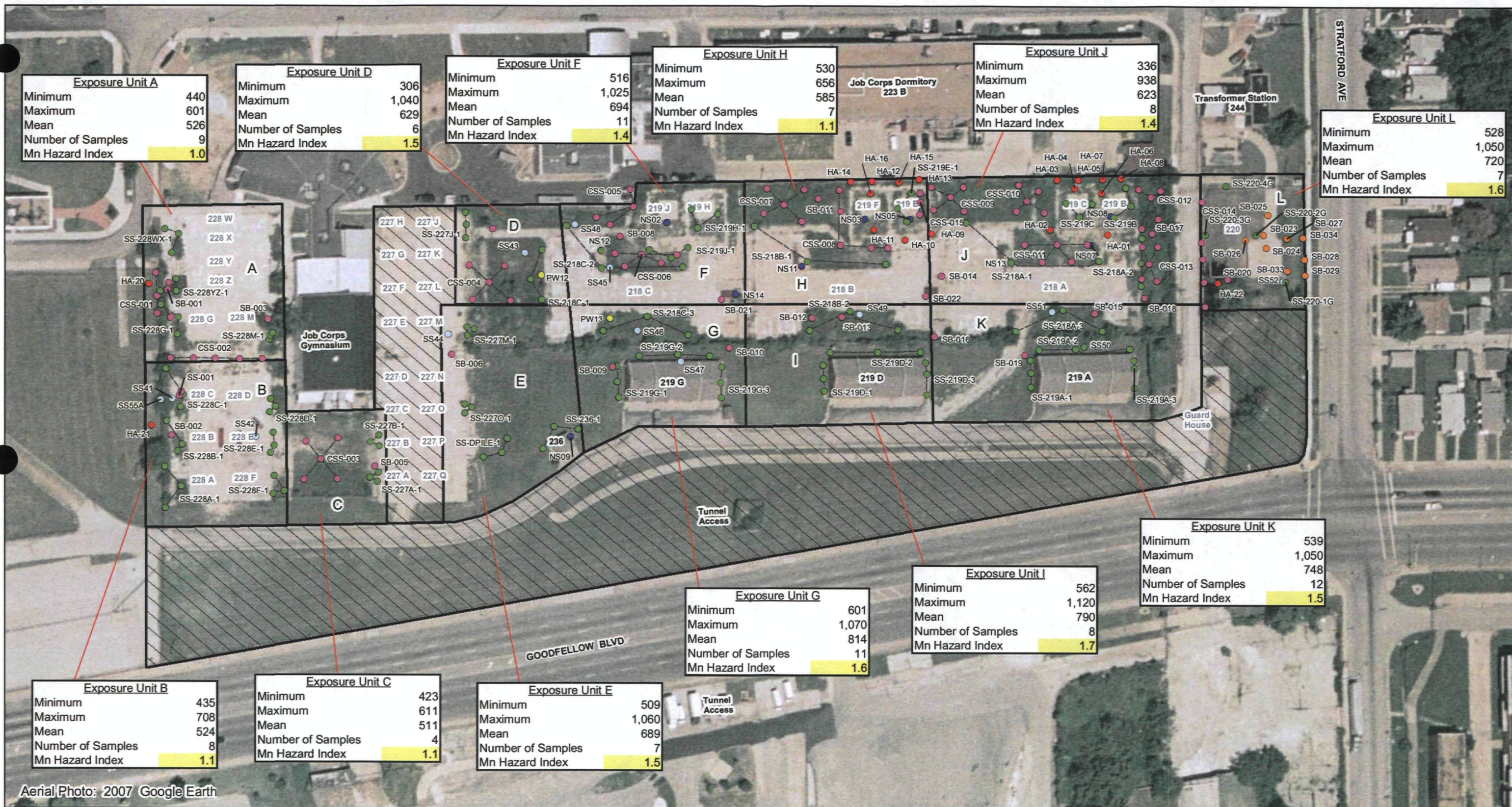


FIGURE 1
MANGANESE CONCENTRATIONS IN SOIL
 St. Louis Ordnance Plant
 Former Hanley Area
 St. Louis, Missouri

CH2MHILL



Aerial Photo: 2007 Google Earth

LEGEND

- 2008 Soil Sample
- 2005/2006 Soil Boring
- 2005 Soil Sample
- 2001 Soil Sample
- 2001 Powder Well
- 1998 Soil Sample Locations
- 1991 Soil Sample
- Composite Sample
- Portion Line
- Site Boundary
- 220 Former Building
- Exposure Unit
- ▨ Non-Exposure Unit

NOTES:

- Concentrations shown are in units of milligrams per kilogram.
- Mn = Manganese
- NS03 (0-1' bgs), NS08 (0-1' bgs), SS-001, SS218A-2, SS-219B, SS-219C, and SS55A not included in risk assessment.

FIGURE 2
SUMMARY OF MANGANESE CONCENTRATIONS
IN EACH EXPOSURE UNIT
St. Louis Ordnance Plant
Former Hanley Area
St. Louis, Missouri
CH2MHILL

FIGURE 3
Probability Plots for Manganese Concentrations

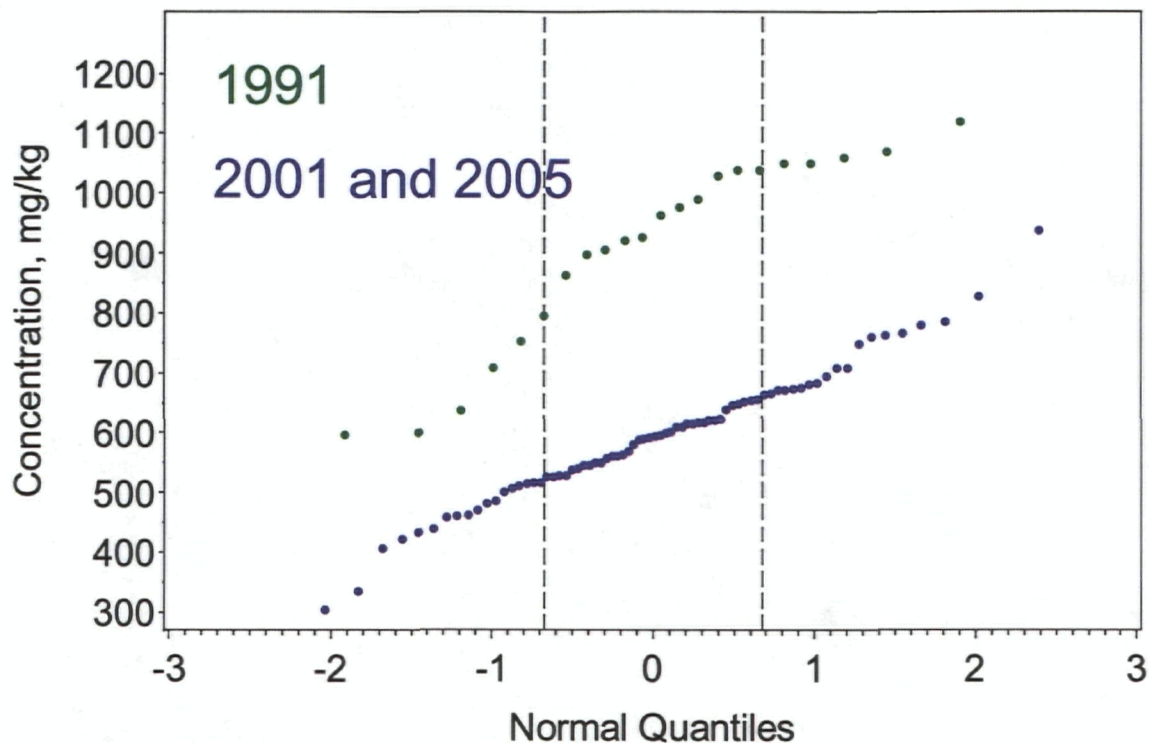


FIGURE 4
Probability Plots for Log of Manganese Results

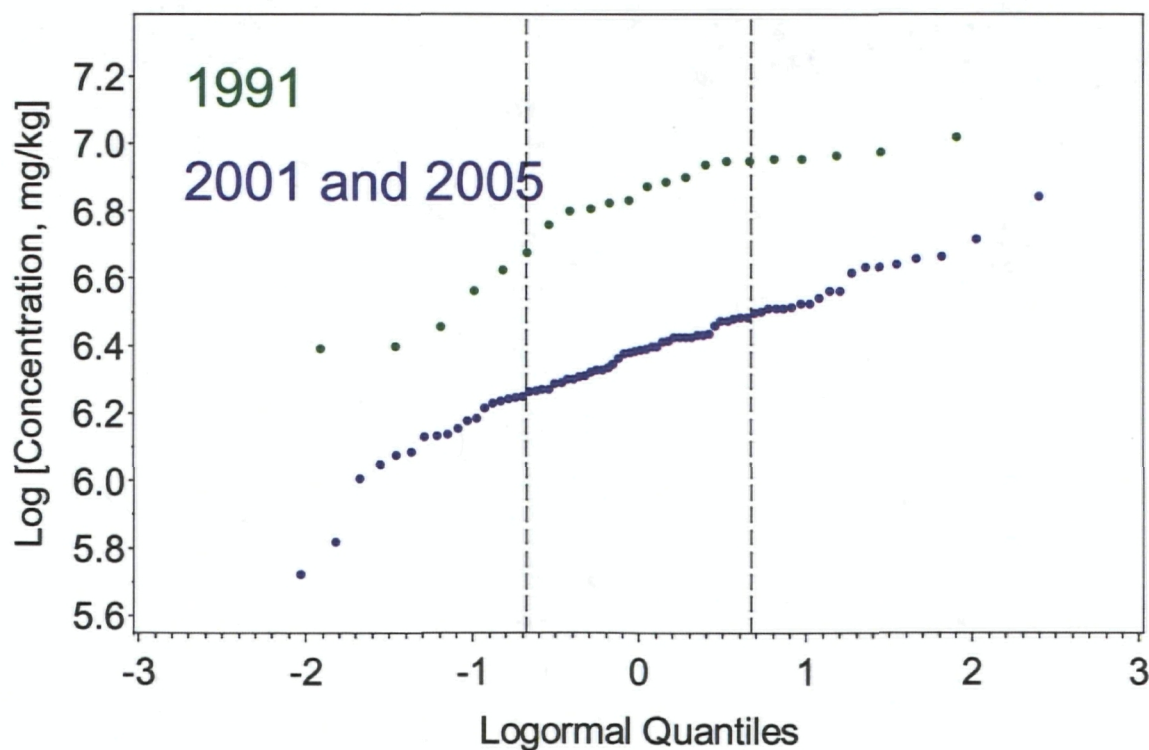


TABLE W-1

Soil Ecological Screening Values Proposed to Supplement DTLs during Initial Site Screening Step
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Chemical	Soil (µg/kg) ^a
Acenaphthene	6.82 e+5
Acenaphthylene	6.82 e+5
Acetone	2,500 ^b
Acetonitrile	1,370 ^b
Acetophenone	3 e+5
Acetylaminofluorene	596
Acrolein	5,270 ^b
Acrylonitrile	23.9 ^b
Aldrin	3.32 ^c
Allyl chloride	13.4
Aminobiphenyl	3.05
Aniline	56.8 ^b
Anthracene	1.48 e+6
Antimony (Total)	142
Aramite	1.66 e+5
Arsenic (Total)	5,700
Azobenzene [p-(dimethylamino)]	40
Barium (Total)	1,040
Benzene	255
Benzo[a]anthracene	5,210
Benzo[a]pyrene	1,520
Benzo[b]fluoranthene	5.98 e+4
Benzo[ghi]perylene	1.19 e+5
Benzo[k]fluoranthene	1.48 e+5
Benzyl alcohol	6.58 e+4
Beryllium (Total)	1,060
BHC [alpha-]	99.4
BHC [beta-]	3.98 ^c
BHC [delta-]	9,940
BHC [gamma-]	5 ^c
Bromodichloromethane	540
Bromoform	1.59 e+4
Butylamine [N-Nitrosodi-n-]	267
Butylbenzyl phthalate	239
Cadmium (Total)	2.22
Carbon disulfide	94.1
Carbon tetrachloride	2,980
Chlordane	224 ^c
Chlorethyl ether [bis(2-]	2.37 e+4 ^b
Chloro-1-methylethyl)ether [bis(2-]	1.99 e+4
Chloroaniline [p-]	1,100
Chlorobenzene	1.31 e+4
Chlorobenzilate	5,050
Chloroform	1,190
Chloronaphthalene [2-]	12.2
Chlorophenol [2-]	243

TABLE W-1

Soil Ecological Screening Values Proposed to Supplement DTLs during Initial Site Screening Step

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Chemical	Soil (µg/kg)^a
Chloroprene 126-99-8	2.9
Chromium+3 (Total)	400 ^d
Chrysene	4,730
Cobalt (Total)	140
Copper (Total)	5,400
Cresol [4,6-dinitro-o-]	144
Cresol [m-]	3,490
Cresol [o-]	4.04 e+4
Cresol [p-chloro-m-]	7,950
Cresol [p-]	1.63 e+5
Cyanide	1,330 ^b
DDD [4,4'-]	758
DDE [4,4'-]	596
DDT [4,4'-]	3.5 ^e
Di-n-butyl phthalate	150
Di-n-octyl phthalate	7.09 e+5
Diallate	452 ^b
Dibenz[a,h]anthracene	1.84 e+4
Dibromo-3-chloropropane	35.2
Dibromochloromethane	2,020
Dibromoethane [1,2-]	1,230
Dichlorobenzene [m-]	3.77 e+4
Dichlorobenzene [o-]	2,960
Dichlorobenzene [p-]	456
Dichlorobenzidine [3,3'-]	646
Dichlorodifluoromethane	3.95 e+4
Dichloroethane [1,1-]	2.01 e+4
Dichloroethane [1,2-]	2.12 e+4
Dichloroethene [1,1-]	8,280
Dichloroethylene [trans-1,2-]	784
Dichlorophenol [2,4-]	8.75 e+4
Dichlorophenol [2,6-]	1,170
Dichloropropane [1,2-]	3.27 e+4
Dichloropropene [cis-1,3-]	398
Dichloropropene [trans-1,3-]	398
Dieldrin	2.38
Diethyl O-2-pyrazinyl phosphorothioate [O,O-]	799
Diethyl phthalate	2.48 e+4
Dimethoate	218
Dimethyl phthalate	7.34 e+5
Dimethylbenzidine [3,3'-]	104
Dimethylbenz[a]anthracene [7,12-]	1.63 e+4
Dimethylphenethylamine [alpha,alpha-]	300
Dimethylphenol [2,4-]	10 ^c
Dinitrobenzene [m-]	655
Dinitrophenol [2,4-]	60.9

TABLE W-1

Soil Ecological Screening Values Proposed to Supplement DTLs during Initial Site Screening Step
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Chemical	Soil (µg/kg) ^a
Dinitrotoluene [2,4-]	1,280
Dinitrotoluene [2,6-]	32.8
Dinoseb	21.8
Dioxane [1,4-]	2,050 ^b
Diphenylamine	1,010
Disulfoton	19.9
D [2,4-]	27.2
Endosulfan I	119
Endosulfan II	119
Endosulfan sulfate	35.8
Endrin	10.1
Endrin aldehyde	10.5
Ethyl methacrylate	3 e+4
Ethylbenzene	5160
Famphur	49.7
Fluoranthene	1.22 e+5
Fluorene	1.22 e+5
Heptachlor	5.98
Heptachlor epoxide	152
Hexachlorobenzene	199
Hexachlorobutadiene	39.8
Hexachlorocyclopentadiene	755
Hexachloroethane	596
Hexachlorophene	199
Hexanone [2-]	1.26 e+4
Indeno (1,2,3-cd) pyrene	1.09 e+5
Isobutyl alcohol	2.08 e+4
Isodrin	3.32 ^c
Isophorone	1.39 e+5
Isosafrole	9,940
Kepone	32.7
Lead (Total)	53.7
Mercury (Total)	100 ^d
Methacrylonitrile	57 ^b
Methane [bis(2-chloroethoxy)]	302 ^b
Methapyrilene	2,780 ^b
Methoxychlor	19.9
Methyl bromide	235 ^b
Methyl chloride	1.04 e+4 ^b
Methyl ethyl ketone	8.96 e+4 ^b
Methyl iodide	1,230
Methyl mercury	1.58
Methyl methacrylate	9.84 e+5 ^b
Methyl methanesulfonate	315 ^b
Methyl parathion	0.292

TABLE W-1

Soil Ecological Screening Values Proposed to Supplement DTLs during Initial Site Screening Step
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Chemical	Soil (µg/kg) ^a
Methyl-2-pentanone [4-]	4.43 e+5
Methylcholanthrene [3-]	77.9
Methylene bromide	6.5 e+4 ^b
Methylene chloride	4,050 ^b
Methylnaphthalene [2-]	3,240
Naphthalene	99.4
Naphthoquinone [1,4-]	1,670
Naphthylamine [1-]	9,340
Naphthylamine [2-]	3,030
Nickel (Total)	1.36 e+4
Nitroaniline [m-]	3,160
Nitroaniline [o-]	7.41 e+4
Nitroaniline [p-]	2.19 e+4
Nitrobenzene	1,310
Nitrophenol [o-]	1,600
Nitrophenol [p-]	5,120
Nitroquinoline-1-oxide [4-]	122
Nitrosodiethylamine [N-]	69.3 ^b
Nitrosodimethylamine [N-]	0.0321 ^b
Nitrosodiphenylamine [N-]	545
Nitrosomethylethylamine [N-]	1.66 ^b
Nitrosomorpholine [N-]	70.6 ^b
Nitrosopiperidine [N-]	6.65 ^b
Nitrosopyrrolidine [N-]	12.6 ^b
Parathion	0.34 ^d
Pentachlorobenzene	497
Pentachloroethane	1.07 e+4
Pentachloronitrobenzene	7,090
Pentachlorophenol	119
Phenacetin	1.17 e+4
Phenanthrene	4.57 e+4
Phenol	1.2 e+5
Phenylenediamine [p-]	6,160 ^b
Phorate	0.496
Phthalate [bis(2-ethylhexyl)]	925
Picoline [2-]	9,900 ^b
Polychlorinated biphenyls	0.332
Polychlorinated dibenzo-p-dioxins	1.99 e-4
Polychlorinated dibenzofurans	0.0386
Pronamide	13.6 ^c
Propionitrile	49.8
Propylamine [N-nitrosodi-n-]	544
Pyrene	7.85 e+4
Pyridine	1,030 ^b
Safrole	404

TABLE W-1

Soil Ecological Screening Values Proposed to Supplement DTLs during Initial Site Screening Step
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Chemical	Soil (µg/kg) ^a
Selenium (Total)	27.6
Silver (Total)	4,040
Silvex	109 ^c
Styrene	4,690
Sulfide	3.58
Tetrachlorobenzene [1,2,4,5-]	2,020
Tetrachlorodibenzo-p-dioxin [2,3,7,8-]	1.99 e-4
Tetrachloroethane [1,1,1,2-]	2.25 e+5
Tetrachloroethane [1,1,2,2-]	127
Tetrachloroethene	9,920
Tetrachlorophenol	199
Tetraethyl dithiopyrophosphate	596
Thallium (Total)	56.9
Tin (Total)	7,620
Toluene	5,450
Toluidine [5-nitro-o-]	8,730
Toluidine [o-]	2,970 ^b
Toxaphene	119
Trichlorobenzene [1,2,4-]	1.11 e+4
Trichloroethane [1,1,1-]	2.98 e+4
Trichloroethane [1,1,2-]	2.86 e+4
Trichloroethylene	1.24 e+4
Trichlorofluoromethane	1.64 e+4
Trichlorophenol [2,4,5-]	1.41 e+4
Trichlorophenol [2,4,6-]	9,940
Trichloropropane [1,2,3-]	3,360
Trichlorophenoxyacetic acid [2,4,5-]	596
Triethyl phosphorothioate [O,O,O-]	818
Trinitrobenzene [Sym-]	376 ^b
Vanadium (Total)	1,590
Vinyl acetate	1.27 e+4 ^b
Vinyl chloride	646
Xylenes (total)	1 e+4 ^c
Zinc (Total)	6,620 ^d

Source: USEPA Region 5 RCRA Ecological Screening Levels (USEPA 2003).

^a Unless noted otherwise, all Soil ESLs are based on exposure to a masked shrew (*Sorex cinereus*).

^b Soil ESL is based on exposure to a meadow vole (*Microtus pennsylvanicus*).

^c Soil ESL is based on exposure to a plant.

^d Soil ESL is based on exposure to soil invertebrates (e.g., earthworms).

TABLE W-2

Soil Samples Used in Ecological Risk Evaluation

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Sample ID	Date	Sample ID	Date	Sample ID	Date
CSS-001	2005	NS09A	1998	SS-220-3	2001
CSS-003	2005	NS09B	1998	SS-220-4	2001
CSS-004	2005	NS11A	1998	SS-227A-1	2001
CSS-005	2005	NS11B	1998	SS-227B-1	2001
CSS-006	2005	NS12A	1998	SS-227J-1	2001
CSS-007	2005	NS12B	1998	SS-227M-1	2001
CSS-008	2005	NS13A	1998	SS-227O-1	2001
CSS-009	2005	NS13B	1998	SS-228A-1	2001
CSS-010	2005	SB-003	2005	SS-228B-1	2001
CSS-011	2005	SB-006	2005	SS-228D-1	2001
CSS-012	2005	SB-010	2005	SS-228E-1	2001
CSS-013	2005	SB-023	2007	SS-228F-1	2001
CSS-014	2005	SB-024	2007	SS-228G-1	2001
CSS-015	2005	SB-025	2007	SS-228M-1	2001
HA-01	2008	SB-026	2007	SS-228WX-1	2001
HA-02	2008	SB-027	2007	SS-228YZ-1	2001
HA-03	2008	SB-028	2007	SS-236-1	2001
HA-04	2008	SB-029	2007	SS41A	1991
HA-05	2008	SB-033	2007	SS42A	1991
HA-06	2008	SB-034	2007	SS43A	1991
HA-07	2008	SS-218A-1	2001	SS43B	1991
HA-08	2008	SS-218A-3	2001	SS44A	1991
HA-09	2008	SS-218B-1	2001	SS44B	1991
HA-10	2008	SS-218B-2	2001	SS45A	1991
HA-11	2008	SS-218C-1	2001	SS45B	1991
HA-12	2008	SS-218C-2	2001	SS46A	1991
HA-13	2008	SS-218C-3	2001	SS46B	1991
HA-14	2008	SS-219A-1	2001	SS47A	1991
HA-15	2008	SS-219A-2	2001	SS47B	1991
HA-16	2008	SS-219A-3	2001	SS48A	1991
HA-20	2008	SS-219D-1	2001	SS48B	1991
HA-21	2008	SS-219D-2	2001	SS49A	1991
HA-22	2008	SS-219D-3	2001	SS49B	1991
NS02A	1998	SS-219E	2001	SS50A	1991
NS02B	1998	SS-219G-1	2001	SS50B	1991
NS03B	1998	SS-219G-2	2001	SS51A	1991
NS05A	1998	SS-219G-3	2001	SS51B	1991
NS05B	1998	SS-219H	2001	SS52A	1991
NS07A	1998	SS-219J-1	2001	SS52B	1991
NS07B	1998	SS-220-1	2001		
NS08B	1998	SS-220-2	2001		

TABLE W-3

Comparison of Detected Surface Soil Concentrations to DTLs and Supplemental Values

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Constituent	Range of Non-Detect Values	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Detected Concentration	Screening Value	Frequency of Exceedance	Maximum Hazard Quotient
Inorganics (mg/kg)							
Aluminum	-- --	75 / 75	12,900	SS43B	NSV	-- / --	NSV
Antimony	3.8 - 3.8	11 / 17	14.1	SS-227O-1	0.142	11 / 17	99
Arsenic	0.25 - 0.25	72 / 75	36.3	HA-05	5.7	73 / 76	6.4
Barium	-- --	91 / 91	723	NS13A	1.04	92 / 92	695
Beryllium	1.8 - 1.8	50 / 72	0.632	SS-219G-3	1.06	0 / 73	0.60
Cadmium	3.05 - 3.05	53 / 75	3.17	SS-228YZ-1	0.0022	54 / 76	1,441
Calcium	-- --	76 / 76	80,321	SS-228F-1	NSV	-- / --	NSV
Chromium	12.7 - 12.7	72 / 92	57.7	SS44B	0.4	73 / 93	144
Cobalt	15 - 15	54 / 61	12.4	CSS-010	0.14	55 / 62	89
Copper	58.6 - 58.6	54 / 76	410.2	CSS-011	5.4	55 / 77	76
Iron	-- --	76 / 76	21,855	CSS-001	NSV	-- / --	NSV
Lead	-- --	96 / 96	1,416	SS-228B-1	0.0537	96 / 96	26,369
Magnesium	-- --	76 / 76	20,570	SS-228D-1	NSV	-- / --	NSV
Manganese	-- --	76 / 76	1,120	SS49B	NSV	-- / --	NSV
Mercury	0.05 - 0.05	14 / 36	0.57	SS-219E	0.1	1 / 36	5.7
Nickel	12.6 - 12.6	73 / 76	32.2	SS44B	13.6	74 / 77	2.4
Potassium	-- --	76 / 76	10,923	SS-236-1	NSV	-- / --	NSV
Selenium	0.25 - 0.25	14 / 21	12.4	SS-228YZ-1	0.0276	14 / 21	449
Silver	2.5 - 2.5	10 / 32	82.6	NS05B	4.04	2 / 33	20
Sodium	-- --	76 / 76	678	SS44B	NSV	-- / --	NSV
Thallium	31.3 - 31.3	12 / 19	8.64	SS-218A-1	0.0569	13 / 20	152
Vanadium	-- --	61 / 61	51.2	SS52B	1.59	62 / 62	32
Zinc	-- --	76 / 76	1,305	SS-227A-1	6.62	77 / 77	197

TABLE W-3

Comparison of Detected Surface Soil Concentrations to DTLs and Supplemental Values

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Constituent	Range of Non-Detect Values	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Detected Concentration	Screening Value	Frequency of Exceedance	Maximum Hazard Quotient
Semivolatile Organic Compounds (mg/kg)							
Acenaphthene	0.243 - 0.243	10 / 11	0.1152	SB-010	682	0 / 12	0.000
Acenaphthylene	0.243 - 0.243	1 / 2	0.00579	CSS-005	682	0 / 2	0.0000085
Anthracene	0.03 - 0.03	12 / 17	35.53	CSS-011	148	0 / 18	0.24
Benzo(a)anthracene	0.17 - 0.17	12 / 17	0.7295	SB-010	5.21	1 / 18	0
Benzo(a)pyrene	-- --	17 / 17	0.5053	SB-010	1.52	1 / 18	0
Benzo(b)fluoranthene	0.21 - 0.21	17 / 22	0.8186	SB-010	59.8	1 / 23	0.0
Benzo(g,h,i)perylene	-- --	13 / 13	0.3555	SB-010	119	1 / 14	0.0
Benzo(k)fluoranthene	0.07 - 0.07	16 / 21	0.3967	CSS-005	148	0 / 22	0.00
Chrysene	0.12 - 0.12	14 / 17	0.5776	CSS-009	4.73	1 / 18	0
Dibenz(a,h)anthracene	-- --	11 / 11	0.0811	SB-010	18.4	1 / 12	0.0
Fluoranthene	0.07 - 0.07	16 / 18	1.5901	CSS-009	122	1 / 19	0.0
Fluorene	0.243 - 0.243	10 / 11	0.0602	CSS-009	122	0 / 12	0.00
Indeno(1,2,3-cd)pyrene	-- --	13 / 13	0.3387	SB-010	109	1 / 14	0.0
Naphthalene	0.0012 - 0.243	6 / 13	0.0145	CSS-009	0.0994	1 / 7	0
Phenanthrene	0.03 - 0.03	14 / 17	0.9221	CSS-009	45.7	0 / 18	0.020
Pyrene	0.03 - 0.03	16 / 18	1.2396	SB-010	78.5	1 / 19	0.0
Volatile Organic Compounds (mg/kg)							
1,1-Dichloroethene	0.0058 - 0.0065	1 / 7	0.00086	SB-023	8.28	0 / 7	0.00010
1,2,4-Trichlorobenzene	0.0058 - 0.0065	1 / 7	0.0021	SB-027	11.1	0 / 7	0.00019
1,2,4-Trimethylbenzene	0.00071 - 0.0065	1 / 7	0.011	SB-027	NSV	-- / --	NSV
1,2-Dichlorobenzene	0.0058 - 0.0065	1 / 7	0.0055	SB-024	2.96	0 / 7	0.0019
1,3,5-Trimethylbenzene	0.00083 - 0.0065	1 / 7	0.0051	SB-023	NSV	-- / --	NSV
1,3-Dichlorobenzene	0.0058 - 0.0065	1 / 7	0.00078	SB-024	37.7	0 / 7	0.000021
4-Isopropyltoluene	0.0058 - 0.0065	1 / 7	0.0015	SB-023	NSV	-- / --	NSV
cis-1,2-Dichloroethene	0.006 - 0.0065	6 / 9	0.7	SB-023	21.2	0 / 9	0.033
n-Butylbenzene	0.0022 - 0.0065	1 / 7	0.0025	SB-027	NSV	-- / --	NSV
Tetrachloroethene	0.006 - 0.0063	9 / 9	6.4	SB-023	9.92	0 / 9	0.65
Toluene	0.0058 - 0.0065	3 / 7	0.001	SB-023	5.45	0 / 7	0.0002
trans-1,2-Dichloroethene	0.0058 - 0.0065	3 / 9	0.036	SB-023	0.784	0 / 9	0.046
Trichloroethene	0.006 - 0.0065	6 / 9	0.81	SB-028	12.4	0 / 9	0.065

NSV = No screening Value

TABLE W-4**Results of MRBCA Appendix F Checklist A*****St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri***

Checklist Question	
Is the boundary of the contaminated area less than ½ mile to a surface waterbody (stream, river, pond, lake, etc.)?	N
Are wetlands (as defined by the 1987 Corps of Engineers' Delineation Manual) on or adjacent to the site?	N
Are contaminated soils uncovered or otherwise accessible to ecological receptors and the elements?	Y
Are there karstic features (see Ecological Risk Assessment Figure #2 for definition) on or within ½ mile of the boundary of the contaminated area?	N
Are there federal or state rare, threatened, or endangered species on or within ½ mile of the contaminated area?	P
Are there one or more environmentally sensitive areas (see Ecological Risk Assessment Figure #1 for definition) at or within ½ mile of the contaminated area?	N
Are commercially or recreationally important species (fauna or flora) on or within ½ mile of the contaminated area?	N

Notes:

Y - Yes

N - No

P - Potential

TABLE W-5

Results of MRBCA Appendix F Checklist B

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Checklist Questions	
Question 1: Could contaminants associated with the site reach ecological receptors via groundwater?	N
1.a.) Can contaminants associated with the site leach, dissolve, or otherwise migrate to groundwater?	
1.b.) Are contaminants associated with the site mobile in groundwater?	
1.c.) Does groundwater from the site discharge to ecological receptor habitat?	
Question 2: Could contaminants from the site reach ecological receptors by migration of NAPL?	N
2.a.) Is NAPL present at the site?	
2.b.) Is NAPL migrating?	
2.c.) Could NAPL discharge occur where ecological receptors are found?	
Question 3: Could contaminants reach ecological receptors via erosional transport of contaminated soils or via precipitation runoff?	
3.a.) Are contaminants present in surface soils?	Y
3.b.) Can contaminants be leached from or be transported by erosion of surface soils?	Y
Question 4: Could contaminants reach ecological receptors via direct contact?	
4.a.) Are contaminants present in surface soil or on the surface of the ground?	Y
4.b.) Are potential ecological receptors on the site?	Y
Question 5: Could contaminants reach ecological receptors via inhalation of volatilized contaminants or contaminants adhered to dust in ambient air or in subsurface burrows?	
5.a.) Are contaminants present on the site volatile?	P
5.b.) Could contaminants on the site be transported in air as dust or particulate matter?	Y
Question 6: Could contaminants reach ecological receptors via direct ingestion of soil, plants, animals, or contaminants?	
6.a.) Are contaminants present in surface and shallow subsurface soils or on the surface of the ground?	Y
6.b.) Are contaminants found in soil on the site taken up by plants growing on the site?	Y
6.c.) Do potential ecological receptors on or near the site feed on plants (e.g., grasses, shrubs, forbs, trees, etc.) found on the site?	Y
6.d.) Do contaminants found on the site bioaccumulate?	Y
Question 7: Could contaminants reach ecological receptors via transport through a karst system?	
7.a.) Are there karstic features (see Ecological Risk Assessment Figure #2 for definition) on or within ½ mile of the contaminated area?	N
7.b.) Is there a hydrogeological connection between the site and karstic features such as seeps, springs, streams, or other surface water bodies?	N

Notes:

Y = Yes

N = No

P = Potential

TABLE W-6

Assessment Endpoints, Risk Hypotheses, and Measurement Endpoints

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Assessment Endpoint	Risk Hypothesis	Measurement Endpoint	Receptor
Terrestrial Habitats			
Survival, growth, and reproduction of terrestrial soil invertebrate communities	Are site related PCOC concentrations in surface soils sufficient to adversely affect soil invertebrate communities?	Comparison of constituent concentrations in surface soils with soil screening values	Soil invertebrates (earthworms)
Survival, growth, and reproduction of terrestrial plant communities	Are site-related PCOC concentrations in surface soils sufficient to adversely affect terrestrial plant communities?	Comparison of constituent concentrations in surface soils with soil screening values	Terrestrial plants
Survival, growth, and reproduction of terrestrial reptile populations	Are site-related PCOC concentrations in surface soil sufficient to adversely affect terrestrial reptile populations?	Comparison of constituent concentrations in surface soils with soil screening values Evidence of potential risk to other upper trophic level terrestrial receptors evaluated in the ERA	Reptiles
Survival, growth, and reproduction of avian terrestrial herbivore populations	Are site-related PCOC concentrations in surface soils sufficient to cause adverse effects (on growth, survival, or reproduction) to avian receptor populations that may consume terrestrial plants from the site?	Comparison of modeled dietary intakes using surface soil concentrations with literature-based ingestion screening values; ratios >1 based upon the NOAEL-LOAEL range indicate an effect	Rufous-sided Towhee
Survival, growth, and reproduction of avian terrestrial insectivore/omnivore populations	Are site-related PCOC concentrations in surface soils sufficient to cause adverse effects (on growth, survival, or reproduction) to avian receptor populations that may consume terrestrial plants and soil invertebrates from the site?	Comparison of modeled dietary intakes using surface soil concentrations with literature-based ingestion screening values; ratios >1 based upon the NOAEL-LOAEL range indicate an effect	Wild Turkey
Survival, growth, and reproduction of avian terrestrial carnivore populations	Are site-related PCOC concentrations in surface soils sufficient to cause adverse effects (on growth, survival, or reproduction) to avian receptor populations that may consume small mammals from the site?	Comparison of modeled dietary intakes using surface soil concentrations with literature-based ingestion screening values; ratios >1 based upon the NOAEL-LOAEL range indicate an effect	Bald Eagle
Survival, growth, and reproduction of mammalian terrestrial herbivore populations	Are site-related PCOC concentrations in surface soils sufficient to cause adverse effects (on growth, survival, or reproduction) to mammalian receptor populations that may consume terrestrial plants from the site?	Comparison of modeled dietary intakes using surface soil concentrations with literature-based ingestion screening values; ratios >1 based upon the NOAEL-LOAEL range indicate an effect	White-tailed deer
Survival, growth, and reproduction of mammalian terrestrial invertivore populations	Are site-related PCOC concentrations in surface soils sufficient to cause adverse effects (on growth, survival, or reproduction) to mammalian receptor populations that may consume soil invertebrates from the site?	Comparison of modeled dietary intakes using surface soil concentrations with literature-based ingestion screening values; ratios >1 based upon the NOAEL-LOAEL range indicate an effect	Short-tailed shrew

TABLE W-6

Assessment Endpoints, Risk Hypotheses, and Measurement Endpoints

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Assessment Endpoint	Risk Hypothesis	Measurement Endpoint	Receptor
Survival, growth, and reproduction of mammalian terrestrial omnivore populations	Are site-related PCOC concentrations in surface soils sufficient to cause adverse effects (on growth, survival, or reproduction) to mammalian receptor populations that may consume terrestrial plants and soil invertebrates from the site?	Comparison of modeled dietary intakes using surface soil concentrations with literature-based ingestion screening values; ratios >1 based upon the NOAEL-LOAEL range indicate an effect	White-footed mouse
Survival, growth, and reproduction of mammalian terrestrial carnivore populations	Are site-related PCOC concentrations in surface soils sufficient to cause adverse effects (on growth, survival, or reproduction) to mammalian receptor populations that may consume small mammals from the site?	Comparison of modeled dietary intakes using surface soil concentrations with literature-based ingestion screening values; ratios >1 based upon the NOAEL-LOAEL range indicate an effect	Coyote

TABLE W-7

Soil Bioaccumulation Factors

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Inorganics	Soil-Plant BCF (dry weight)		Soil-Invertebrate BAF (dry weight)	
	Value	Reference	Value	Reference
Arsenic	1.1	90th Percentile; Bechtel Jacobs 1998	0.52	90th Percentile; Sample et al. 1998a
Cadmium	3.3	90th Percentile; Bechtel Jacobs 1998	41	90th Percentile; Sample et al. 1998a
Chromium	0.084	90th Percentile; Bechtel Jacobs 1998	3.2	90th Percentile; Sample et al. 1998a
Copper	0.63	90th Percentile; Bechtel Jacobs 1998	1.5	90th Percentile; Sample et al. 1998a
Lead	0.47	90th Percentile; Bechtel Jacobs 1998	1.5	90th Percentile; Sample et al. 1998a
Mercury	5.0	90th Percentile; Bechtel Jacobs 1998	21	90th Percentile; Sample et al. 1998a
Nickel	1.4	90th Percentile; Bechtel Jacobs 1998	4.7	90th Percentile; Sample et al. 1998a
Selenium	3.0	90th Percentile; Bechtel Jacobs 1998	1.3	90th Percentile; Sample et al. 1998a
Silver	0.037	90th Percentile; Bechtel Jacobs 1998	15	90th Percentile; Sample et al. 1998a
Zinc	1.8	90th Percentile; Bechtel Jacobs 1998	13	90th Percentile; Sample et al. 1998a

Inorganics	Soil-Mouse BAF (dry weight)		Soil-Shrew BAF (dry weight)	
	Value	Reference	Value	Reference
Arsenic	0.014	90th Percentile; Sample et al. 1998a	0.015	90th Percentile; Sample et al. 1998b
Cadmium	0.46	90th Percentile; Sample et al. 1998a	7.0	90th Percentile; Sample et al. 1998b
Chromium	0.35	90th Percentile; Sample et al. 1998a	0.33	90th Percentile; Sample et al. 1998b
Copper	0.55	90th Percentile; Sample et al. 1998a	1.1	90th Percentile; Sample et al. 1998b
Lead	0.29	90th Percentile; Sample et al. 1998a	0.34	90th Percentile; Sample et al. 1998b
Mercury	0.13	90th Percentile; Sample et al. 1998a	0.19	90th Percentile; Sample et al. 1998b
Nickel	0.59	90th Percentile; Sample et al. 1998a	0.58	90th Percentile; Sample et al. 1998b
Selenium	1.3	90th Percentile; Sample et al. 1998a	1.2	90th Percentile; Sample et al. 1998b
Silver	0.81	90th Percentile; Sample et al. 1998a	0.50	90th Percentile; Sample et al. 1998b
Zinc	2.8	90th Percentile; Sample et al. 1998a	2.9	90th Percentile; Sample et al. 1998b

TABLE W-8

Exposure Parameters for Upper Trophic Level Ecological Receptors - Step 2

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Receptor	Body Weight (kg)		Water Ingestion Rate (L/day)		Food Ingestion Rate (kg/day - dry)	
	Value	Reference	Value	Reference	Value	Reference
Birds						
Rufous-sided Towhee	0.03	Clench and Leberman 1978	0.0059	allometric equation	0.0062	allometric equation
Wild Turkey	2.50	Eaton 1992	0.1090	allometric equation	0.1057	allometric equation
Mammals						
Coyote	7.00	Bekoff 1977	0.5705	allometric equation	0.3401	Sample and Suter 1994
Short-tailed shrew	0.013	USEPA 1993	0.0048	USEPA 1993	0.0019	USEPA 1993
White-footed mouse	0.014	Silva and Downing 1995	0.0092	Sample and Suter 1994	0.0007	Sample and Suter 1994
White-tailed deer	52.1	Silva and Downing 1995	3.5636	allometric equation	0.2610	Sample and Suter 1994

TABLE W-8

Exposure Parameters for Upper Trophic Level Ecological Receptors - Step 2

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Receptor	Dietary Composition (percent)					Soil/ Sediment Ingestion (percent)	
	Terr. Plants	Soil Invert.	Small Mammals	Birds	Reference	Value	Reference
Birds							
Rufous-sided Towhee	41.6	58.4	0	0	Greenlaw 1996	0	Greenlaw 1996
Wild Turkey	96.4	3.6	0	0	Shemnitz 1956	0	Shemnitz 1956
Mammals							
Coyote	7.0	2.8	87.4	0	USEPA 1993	2.8	Beyer et al. 1994
Short-tailed shrew	4.7	82.3	0	0	USEPA 1993; Sample and Suter 1994	13.0	Sample and Suter 1994
White-footed mouse	51.0	47.0	0	0	Martin et al. 1951; Sample and Suter 1994	2.0	Beyer et al. 1994
White-tailed deer	98.0	0	0	0	Sample and Suter 1994	2.0	Beyer et al. 1994

TABLE W-9**Surface Soil Direct Exposure Screening Values***St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri*

Inorganics (mg/kg)	Screening Value	Reference
Aluminum	pH Dependent	USEPA 2008
Antimony	78	USEPA 2008
Arsenic	18	USEPA 2008
Barium	330	USEPA 2008
Cadmium	32	USEPA 2008
Chromium	0.4	USEPA 2003
Cobalt	13	USEPA 2008
Copper	70	USEPA 2008
Iron	pH Dependent	USEPA 2008
Lead	120	USEPA 2008
Manganese	220	USEPA 2008
Mercury	0.10	Efroymsen et al. 1997a
Nickel	38	USEPA 2008
Selenium	0.52	USEPA 2008
Silver	560	USEPA 2008
Thallium	1.0	Efroymsen et al. 1997b
Vanadium	2.0	Efroymsen et al. 1997b
Zinc	50	USEPA 2008

TABLE W-10

Ingestion Screening Values for Mammals

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Inorganics	Test Organism	Body Weight (kg)	Duration	Exposure Route	Effect/Endpoint	LOAEL (mg/kg/d)	NOAEL (mg/kg/d)	Reference	White-footed Mouse	Short-tailed Shrew	Coyote	White-tailed Deer
Arsenic	mouse	0.03	3 generations	oral in water	reproduction	1.26	0.13	Sample et al. 1996	X	X		X
Arsenic	dog	10.0	2 years	oral in diet	systemic	12.00	1.20	ATSDR 1993a			X	
Cadmium	rat	0.303	6 weeks	oral (gavage)	reproduction	10.0	1.00	Sample et al. 1996	X	X		X
Cadmium	dog	10.0	3 months	oral in diet	reproduction	7.5	0.75	ATSDR 1999a			X	
Chromium	rat	0.35	1 year	oral in water	body weight/intake	32.8	3.28	Sample et al. 1996	X	X	X	X
Copper	mouse	0.03	1 month + GD 0-19	oral in diet	developmental	104	78.0	ATSDR 2002a	X	X		X
Copper	mink	1.00	357 days	oral in diet	reproduction	15.1	11.7	Sample et al. 1996			X	
Lead	rat	0.35	3 generations	oral in diet	reproduction	80.0	8.00	Sample et al. 1996	X	X	X	X
Mercury	rat	0.35	3 generations	oral in diet	reproduction	0.16	0.032	Sample et al. 1996	X	X		X
Mercury	mink	1.00	93 days	oral in diet	survival/weight loss	0.25	0.15	Sample et al. 1996			X	
Nickel	rat	0.35	3 generations	oral in diet	reproduction	80.0	40.0	Sample et al. 1996	X	X		X
Nickel	dog	10.0	2 years	oral in diet	systemic	62.5	25.0	ATSDR 2003a			X	
Selenium	rat	0.35	1 year	oral in water	reproduction	0.33	0.20	Sample et al. 1996	X	X	X	X
Silver	rat	0.35	2 weeks	oral in water	survival	18.2	1.812	ATSDR 1990	X	X	X	X
Zinc	rat	0.35	GD 1-16	oral in diet	reproduction	320	160	Sample et al. 1996	X	X		X
Zinc	mink	1.00	25 weeks	oral	reproduction	208	20.8	ATSDR 2003b			X	

1 - "X" indicated selected ingestion screening value for given receptor

TABLE W-11

Ingestion Screening Values for Birds

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Inorganics	Test Organism	Body Weight (kg)	Duration	Exposure Route	Effect/Endpoint	LOAEL (mg/kg/d)	NOAEL (mg/kg/d)	Reference	Rufous-sided Towhee	Wild Turkey
Arsenic	brown-headed cowbird	0.049	7 months	oral in diet	survival	7.38	2.46	Sample et al. 1996	X	
Arsenic	mallard	1.00	128 days	oral in diet	survival	12.8	5.14	Sample et al. 1996		X
Cadmium	mallard	1.15	90 days	oral in diet	reproduction	20.0	1.45	Sample et al. 1996	X	X
Chromium	American black duck	1.25	10 months	oral in diet	reproduction	5.00	1.00	Sample et al. 1996	X	X
Copper	chicken (chicks)	0.534	10 weeks	oral in diet	growth/survival	61.70	47.00	Sample et al. 1996	X	X
Lead	Japanese quail	0.15	12 weeks	oral in diet	reproduction	11.3	1.13	Sample et al. 1996		X
Lead	American kestrel	0.13	7 months	oral in diet	reproduction	19.3	3.85	Sample et al. 1996	X	
Mercury	mallard	1.00	3 generations	oral in diet	reproduction	0.078	0.026	USEPA 1997b	X	X
Nickel	mallard	1.00	100 days	oral in diet	reproduction	0.8	0.4	Sample et al. 1996	X	X
Selenium	mallard	0.78	90 days	oral in diet	growth/survival	107	77.4	Sample et al. 1996	X	X
Silver	mallard	1.10	14 days	oral in diet	survival	178	35.6	USEPA 1999b	X	X
Zinc	chicken	1.94	44 weeks	oral in diet	reproduction	131.0	14.50	Sample et al. 1996	X	X

1 - "X" indicated selected ingestion screening value for given receptor

TABLE W-12

Comparison of Detected Surface Soil Concentrations to Direct Exposure Screening Values
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Inorganics (mg/kg)	Maximum Concentration	Screening Value	Maximum Hazard Quotient
Aluminum	12,900	pH Dependent	--
Antimony	14.1	78	0.18
Arsenic	36.3	18	2.0
Barium	723	330	2.2
Cadmium	3.17	32	0.10
Chromium	57.7	0.4	144
Cobalt	12.4	13	0.95
Copper	410.2	70	5.9
Iron	21,855	pH Dependent	--
Lead	1,416	120	12
Manganese	1,120	220	5.1
Mercury	0.57	0.1	5.7
Nickel	32.2	38	0.85
Selenium	12.4	0.52	24
Silver	82.6	560	0.15
Thallium	8.64	1.0	8.6
Vanadium	51.2	2.0	26
Zinc	1,305	120	11

TABLE W-13

Comparison of White-footed Mouse Exposure Doses to Ingestion Screening Values
St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Chemical	Soil Concentration (mg/kg)	Soil - Plant BCF	Terrestrial Plant Concentration (mg/kg dry)	Soil - Invertebrate BAF	Terrestrial Invertebrate Concentration (mg/kg)	Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/d)	NOAEL TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)	NOAEL HQ	LOAEL HQ
Arsenic	36.3	1.103	40.0389	0.523	18.9849	0	1.4927744	0.126	1.26	12	1.2
Cadmium	3.17	3.25	10.3025	40.69	128.9873	0	3.2737017	1	10	3.3	0.33
Chromium	57.7	0.0839	4.84103	3.162	182.4474	0	4.4369675	3.28	32.8	1.4	0.14
Copper	410.2	0.625	256.375	1.531	628.0162	0	21.552199	78	104	0.28	0.21
Lead	1416	0.468	662.688	1.522	2,155	0	68.471534	8	80	8.6	0.86
Mercury	0.57	5	2.85	20.625	11.75625	0	0.347038	0.032	0.16	11	2.2
Nickel	32.2	1.411	45.4342	4.73	152.306	0	4.7361336	40	80	0.12	0.06
Selenium	12.4	3.012	37.3488	1.34	16.616	0	1.3456586	0.2	0.33	6.7	4.1
Silver	82.6	0.0367	3.03142	15.338	1,267	0	29.720206	1.812	18.12	16	1.6
Zinc	1305	1.82	2375.1	12.885	16,815	0	453.77951	160	320	2.8	1.4

$$DI_x = \frac{\sum (FIR)(FC_{xi})(PDF_i) + [(FIR)(SC_x)(PDS) + [(WIR)(WC_x)]]}{BW}$$

DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)
 FIR = 0.0007 = Food ingestion rate (kg/day dry weight)
 FC_{xi} = Chemical-specific = Concentration of chemical in food item (plants, mg/kg, dry weight basis)
 PDF_i = 0.51 = Proportion of diet composed of food item (plants, dry weight basis)
 FC_{xi} = Chemical-specific = Concentration of chemical in food item (invertebrates, mg/kg, dry weight basis)
 PDF_i = 0.47 = Proportion of diet composed of food item (invertebrates, dry weight basis)
 SC_x = Chemical-specific = Concentration of chemical in soil (mg/kg, dry weight)
 PDS = 0.02 = Proportion of diet composed of soil (dry weight basis)
 WIR = 0.0092 = Water ingestion rate (L/day)
 WC_x = Chemical-specific = Concentration of chemical in water (mg/L)
 BW = 0.0141 = Body weight (kg wet weight)

$$HQ = \frac{DI_x}{\text{Screening Value}}$$

TABLE W-14

Comparison of Short-tailed Shrew Exposure Doses to Ingestion Screening Values
 St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Chemical	Soil Concentration (mg/kg)	Soil - Plant BCF	Terrestrial Plant Concentration (mg/kg dry)	Soil - Invertebrate BAF	Terrestrial Invertebrate Concentration (mg/kg)	Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/d)	NOAEL TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)	NOAEL HQ	LOAEL HQ
Arsenic	36.3	1.103	40.0389	0.523	18.9849	0	3.1491918	0.126	1.26	25	2.5
Cadmium	3.17	3.25	10.3025	40.69	128.9873	0	15.168681	1	10	15	1.5
Chromium	57.7	0.0839	4.84103	3.162	182.4474	0	22.370936	3.28	32.8	6.8	0.68
Copper	410.2	0.625	256.375	1.531	628.0162	0	82.498546	78	104	1.1	0.79
Lead	1416	0.468	662.688	1.522	2,155	0	281.81626	8	80	35	3.5
Mercury	0.57	5	2.85	20.625	11.75625	0	1.4004184	0.032	0.16	44	8.8
Nickel	32.2	1.411	45.4342	4.73	152.306	0	18.656658	40	80	0.47	0.23
Selenium	12.4	3.012	37.3488	1.34	16.616	0	2.4147895	0.2	0.33	12	7.3
Silver	82.6	0.0367	3.03142	15.338	1,267	0	149.2817	1.812	18.12	82	8.2
Zinc	1305	1.82	2375.1	12.885	16,815	0	2,001	160	320	13	6.3

$$DI_x = \frac{\sum (FIR)(FC_{xi})(PDF_i) + [(FIR)(SC_x)(PDS) + [(WIR)(WC_x)]]}{BW}$$

DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)

FIR = 0.001885939 = Food ingestion rate (kg/day dry weight)

FC_{xi} = Chemical-specific = Concentration of chemical in food item (plants, mg/kg, dry weight basis)

PDF_i = 0.047 = Proportion of diet composed of food item (plants, dry weight basis)

FC_{xi} = Chemical-specific = Concentration of chemical in food item (invertebrates, mg/kg, dry weight basis)

PDF_i = 0.823 = Proportion of diet composed of food item (invertebrates, dry weight basis)

SC_x = Chemical-specific = Concentration of chemical in soil (mg/kg, dry weight)

PDS = 0.13 = Proportion of diet composed of soil (dry weight basis)

WIR = 0.00475213 = Water ingestion rate (L/day)

WC_x = Chemical-specific = Concentration of chemical in water (mg/L)

BW = 0.01331 = Body weight (kg wet weight)

$$HQ = \frac{DI_x}{\text{Screening Value}}$$

TABLE W-15

Comparison of Coyote Exposure Doses to Ingestion Screening Values

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Chemical	Soil Concentration (mg/kg)	Soil - Plant BCF	Terrestrial Plant Concentration (mg/kg dry)	Soil - Invertebrate BAF	Terrestrial Invertebrate Concentration (mg/kg)	Soil - Mouse BAF	Mouse Concentration (mg/kg)	Soil - Shrew BAF	Shrew Concentration (mg/kg)	Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/d)	NOAEL TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)	NOAEL HQ	LOAEL L HQ
Arsenic	36.3	1.103	40.0389	0.523	18.9849	0.014	0.5082	0.0149	0.54087	0	0.233667	1.2	12	0.19	0.019
Cadmium	3.17	3.25	10.3025	40.69	128.9873	0.462	1.46454	7.017	22.24389	0	0.718236	0.75	7.5	0.96	0.10
Chromium	57.7	0.0839	4.84103	3.162	182.4474	0.349	20.1373	0.3333	19.23141	0	1.179092	3.28	32.8	0.36	0.036
Copper	410.2	0.625	256.375	1.531	628.0162	0.554	227.2508	1.117	458.1934	0	16.83844	11.7	15.14	1.4	1.1
Lead	1,416	0.468	662.688	1.522	2155	0.286	404.976	0.339	480.024	0	25.90351	8	80	3.2	0.32
Mercury	0.57	5	2.85	20.625	11.75625	0.13	0.0741	0.192	0.10944	0	0.03036	0.15	0.25	0.20	0.12
Nickel	32.2	1.411	45.4342	4.73	152.306	0.589	18.9658	0.578	18.6116	0	1.203423	25	62.5	0.048	0.019
Selenium	12.4	3.012	37.3488	1.34	16.616	1.263	15.6612	1.1867	14.71508	0	0.811483	0.2	0.33	4.1	2.5
Silver	82.6	0.0367	3.03142	15.338	1267	0.81	66.906	0.5013	41.40738	0	4.146098	1.812	18.12	2.3	0.23
Zinc	1,305	1.82	2375	12.885	16,815	2.7822	3631	2.9011	3,786	0	190.2083	20.8	208	9.1	0.91

$$DI_x = \frac{\sum (FIR)(FC_x)(PDF_i) + [(FIR)(SC_x)(PDS) + [(WIR)(WC_x)]]}{BW}$$

DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)
 FIR = 0.34 = Food ingestion rate (kg/day dry weight)
 FC_x = Chemical-specific = Concentration of chemical in food item (plants, mg/kg, dry weight basis)
 PDF_i = 0.07 = Proportion of diet composed of food item (plants, dry weight basis)
 FC_x = Chemical-specific = Concentration of chemical in food item (invertebrates, mg/kg, dry weight basis)
 PDF_i = 0.028 = Proportion of diet composed of food item (invertebrates, dry weight basis)
 FC_x = Chemical-specific = Concentration of chemical in food item (mouse, mg/kg, dry weight basis)
 PDF_i = 0.437 = Proportion of diet composed of food item (mouse, dry weight basis)
 FC_x = Chemical-specific = Concentration of chemical in food item (shrew, mg/kg, dry weight basis)
 PDF_i = 0.437 = Proportion of diet composed of food item (shrew, dry weight basis)
 SC_x = Chemical-specific = Concentration of chemical in soil (mg/kg, dry weight)
 PDS = 0.028 = Proportion of diet composed of soil (dry weight basis)
 WIR = 0.57 = Water ingestion rate (L/day)
 WC_x = Chemical-specific = Concentration of chemical in water (mg/L)
 BW = 7 = Body weight (kg wet weight)

$$HQ = \frac{DI_x}{\text{Screening Value}}$$

TABLE W-16

Comparison of White-tailed Deer Exposure Doses to Ingestion Screening Values

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Chemical	Soil Concentration (mg/kg)	Soil - Plant BCF	Terrestrial Plant Concentration (mg/kg dry)	Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/d)	NOAEL TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)	NOAEL HQ	LOAEL HQ
Arsenic	36.3	1.103	40.0389	0	0.2002041	0.126	1.26	1.6	0.16
Cadmium	3.17	3.25	10.3025	0	0.0508968	1	10	0.051	<0.01
Chromium	57.7	0.0839	4.84103	0	0.0295477	3.28	32.8	<0.01	<0.01
Copper	410.2	0.625	256.375	0	1.2997474	78	104	0.017	0.012
Lead	1416	0.468	662.688	0	3.3952756	8	80	0.42	0.042
Mercury	0.57	5	2.85	0	0.0140489	0.032	0.16	0.44	0.088
Nickel	32.2	1.411	45.4342	0	0.2262811	40	80	<0.01	<0.01
Selenium	12.4	3.012	37.3488	0	0.1846028	0.2	0.33	0.92	0.56
Silver	82.6	0.0367	3.03142	0	0.0231583	1.812	18.12	0.013	<0.01
Zinc	1305	1.82	2375.1	0	11.791078	160	320	0.074	0.037

$$DI_x = \frac{\sum (FIR)(FC_{xi})(PDF_i) + [(FIR)(SC_x)(PDS) + (WIR)(WC_x)]}{BW}$$

DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)
 FIR = 0.261 = Food ingestion rate (kg/day dry weight)
 FC_{xi} = Chemical-specific = Concentration of chemical in food item (plants, mg/kg, dry weight basis)
 PDF_i = 0.98 = Proportion of diet composed of food item (plants, dry weight basis)
 SC_x = Chemical-specific = Concentration of chemical in soil (mg/kg, dry weight)
 PDS = 0.02 = Proportion of diet composed of soil (dry weight basis)
 WIR = 3.563555322 = Water ingestion rate (L/day)
 WC_x = Chemical-specific = Concentration of chemical in water (mg/L)
 BW = 52.1 = Body weight (kg wet weight)

$$HQ = \frac{DI_x}{\text{Screening Value}}$$

TABLE W-17

Comparison of Rufous-sided Towhee Exposure Doses to Ingestion Screening Values

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Chemical	Soil Concentration (mg/kg)	Soil - Plant BCF	Terrestrial Plant Concentration (mg/kg dry)	Soil - Invertebrate BAF	Terrestrial Invertebrate Concentration (mg/kg)	Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/d)	NOAEL TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)	NOAEL HQ	LOAEL HQ
Arsenic	36.3	1.103	40.0389	0.523	18.9849	0	5.3676571	2.46	7.38	2.2	0.73
Cadmium	3.17	3.25	10.3025	40.69	128.9873	0	15.403428	1.45	20	11	0.77
Chromium	57.7	0.0839	4.84103	3.162	182.4474	0	21.004294	1	5	21	4.2
Copper	410.2	0.625	256.375	1.531	628.0162	0	91.593835	47	61.7	1.9	1.5
Lead	1416	0.468	662.688	1.522	2,155	0	296.84671	3.85	19.25	77	15
Mercury	0.57	5	2.85	20.625	11.75625	0	1.5577184	0.026	0.078	60	20
Nickel	32.2	1.411	45.4342	4.73	152.306	0	20.8658	77.4	107	0.27	0.20
Selenium	12.4	3.012	37.3488	1.34	16.616	0	4.8834813	0.4	0.8	12	6.1
Silver	82.6	0.0367	3.03142	15.338	1,267	0	143.39264	35.6	178	4.0	0.81
Zinc	1305	1.82	2375.1	12.885	16,815	0	2,091	14.5	131	144	16

$$DI_x = \frac{\sum (FIR)(FC_{xi})(PDF_i) + [(FIR)(SC_x)(PDS) + [(WIR)(WC_x)]]}{BW}$$

DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)

FIR = 0.006191211 = Food ingestion rate (kg/day dry weight)

FC_{xi} = Chemical-specific = Concentration of chemical in food item (plants, mg/kg, dry weight basis)PDF_i = 0.416 = Proportion of diet composed of food item (plants, dry weight basis)FC_{xi} = Chemical-specific = Concentration of chemical in food item (invertebrates, mg/kg, dry weight basis)PDF_i = 0.584 = Proportion of diet composed of food item (invertebrates, dry weight basis)SC_x = Chemical-specific = Concentration of chemical in soil (mg/kg, dry weight)

PDS = 0 = Proportion of diet composed of soil (dry weight basis)

WIR = 0.005878987 = Water ingestion rate (L/day)

WC_x = Chemical-specific = Concentration of chemical in water (mg/L)

BW = 0.032 = Body weight (kg wet weight)

$$HQ = \frac{DI_x}{\text{Screening Value}}$$

TABLE W-18

Comparison of Wild Turkey Exposure Doses to Ingestion Screening Values
 St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Chemical	Soil Concentration (mg/kg)	Soil - Plant BCF	Terrestrial Plant Concentration (mg/kg dry)	Soil - Invertebrate BAF	Terrestrial Invertebrate Concentration (mg/kg)	Surface Water Concentration (mg/L)	Dietary Intake (mg/kg/d)	NOAEL TRV (mg/kg/d)	LOAEL TRV (mg/kg/d)	NOAEL HQ	LOAEL HQ
Arsenic	36.3	1.103	40.0389	0.523	18.9849	0	1.660443	5.14	12.84	0.32	0.13
Cadmium	3.17	3.25	10.3025	40.69	128.9873	0	0.6161054	1.45	20	0.42	0.031
Chromium	57.7	0.0839	4.84103	3.162	182.4474	0	0.4749081	1	5	0.47	0.095
Copper	410.2	0.625	256.375	1.531	628.0162	0	11.402759	47	61.7	0.24	0.18
Lead	1416	0.468	662.688	1.522	2155.152	0	30.283609	1.13	11.3	27	2.7
Mercury	0.57	5	2.85	20.625	11.75625	0	0.1340253	0.026	0.078	5.2	1.7
Nickel	32.2	1.411	45.4342	4.73	152.306	0	2.083179	77.4	107	0.027	0.019
Selenium	12.4	3.012	37.3488	1.34	16.616	0	1.5472187	0.4	0.8	3.9	1.9
Silver	82.6	0.0367	3.03142	15.338	1,267	0	2.0514665	35.6	178	0.058	0.012
Zinc	1,305	1.82	2375.1	12.885	16,815	0	122.37157	14.5	131	8.4	0.93

$$DI_x = \frac{\sum (FIR)(FC_{xi})(PDF_i) + [(FIR)(SC_x)(PDS) + [(WIR)(WCx)]}{BW}$$

DI = Chemical-specific = Dietary intake for chemical (mg chemical/kg body weight/day)

FIR = 0.106 = Food ingestion rate (kg/day dry weight)

FC_{xi} = Chemical-specific = Concentration of chemical in food item (plants, mg/kg, dry weight basis)

PDF_i = 0.964 = Proportion of diet composed of food item (plants, dry weight basis)

FC_{xi} = Chemical-specific = Concentration of chemical in food item (invertebrates, mg/kg, dry weight basis)

PDF_i = 0.036 = Proportion of diet composed of food item (invertebrates, dry weight basis)

SC_x = Chemical-specific = Concentration of chemical in soil (mg/kg, dry weight)

PDS = 0 = Proportion of diet composed of soil (dry weight basis)

WIR = 0.109 = Water ingestion rate (L/day)

WC_x = Chemical-specific = Concentration of chemical in water (mg/L)

BW = 2.5 = Body weight (kg wet weight)

$$HQ = \frac{DI_x}{\text{Screening Value}}$$

TABLE W-19

Soil Bioaccumulation Factors

St. Louis Ordnance Plant, Former Hanley Area, St. Louis, Missouri

Chemical	Soil-Plant BCF (dry weight)		Soil-Invertebrate BAF (dry weight)		Soil-Mouse BAF (dry weight)		Soil-Shrew BAF (dry weight)	
	Value	Reference	Value	Reference	Value	Reference	Value	Reference
Inorganics								
Arsenic	0.037	Geometric Mean; Bechtel Jacobs 1998	0.26	Arithmetic Mean; Sample et al. 1998a	NA		NA	
Cadmium	0.51	Geometric Mean; Bechtel Jacobs 1998	7.7	Geometric Mean; Sample et al. 1998a	NA		NA	
Chromium	0.048	Geometric Mean; Bechtel Jacobs 1998	0.32	Geometric Mean; Sample et al. 1998a	NA		NA	
Copper	0.123	Geometric Mean; Bechtel Jacobs 1998	0.47	Geometric Mean; Sample et al. 1998a	0.111	Geometric Mean; Sample et al. 1998b	0.502	Geometric Mean; Sample et al. 1998b
Lead	0.038	Geometric Mean; Bechtel Jacobs 1998	0.31	Geometric Mean; Sample et al. 1998a	0.055	Geometric Mean; Sample et al. 1998b	0.148	Geometric Mean; Sample et al. 1998b
Mercury	0.34	Geometric Mean; Bechtel Jacobs 1998	1.2	Geometric Mean; Sample et al. 1998a	NA		NA	
Selenium	0.57	Geometric Mean; Bechtel Jacobs 1998	1.0	Geometric Mean; Sample et al. 1998a	0.258	Geometric Mean; Sample et al. 1998b	0.273	Geometric Mean; Sample et al. 1998b
Silver	0.013	Geometric Mean; Bechtel Jacobs 1998	2.0	Median; Sample et al. 1998a	0.151	Geometric Mean; Sample et al. 1998b	0.036	Geometric Mean; Sample et al. 1998b
Zinc	0.36	Geometric Mean; Bechtel Jacobs 1998	2.5	Geometric Mean; Sample et al. 1998a	0.509	Geometric Mean; Sample et al. 1998b	0.862	Geometric Mean; Sample et al. 1998b
Semivolatiles								
Benzo(b)fluoranthene	0.010	Travis and Arms 1988	0.210	Beyer and Stafford 1993	NA		NA	
Benzo(g,h,i)perylene	0.01	Travis and Arms 1988	0.15	Beyer and Stafford 1993	NA		NA	
Indeno(1,2,3-	0.006	Travis and Arms 1988	0.410	Beyer and Stafford 1993	NA		NA	
Pyrene	0.04	Travis and Arms 1988	0.39	Beyer and Stafford 1993		NA	NA	

NA = Not applicable because chemical not evaluated in medium